

Railway Engineering and Maintenance



5363

Under heaviest
loads and at
highest speeds

IMPROVED TURBO POWER

IMPROVE TRACK

They have GREAT
reserve power
and are NEVER
flat in service



Reliance HY-CROME Spring Washers

A natural mechanical device — scientifically made—to keep bolts tight.



**STANDARD
HY-CROME**

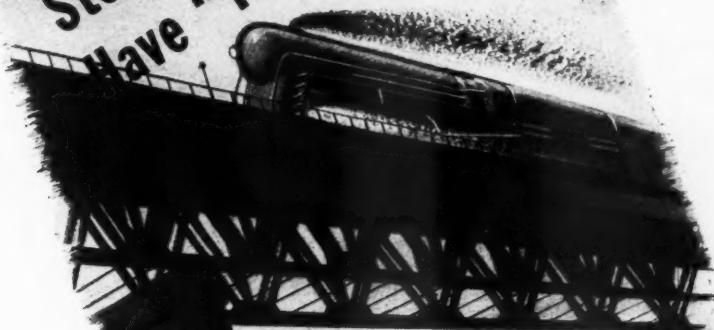
A long record of dependable railroad service and efficiently meeting War demands of present heavy railroad traffic.

Eaton Manufacturing Company
RELIANCE SPRING WASHER DIVISION
MASSILLON, OHIO

New York • Cleveland • Detroit • Chicago • St. Louis • San Francisco • Montreal

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*Steel Bridges
Have "Termites" Too . . .*



Steel-hungry corrosive elements . . . like the destructive termites in wood . . . eat into steel structures and undermine their weight and strength. This steel-consuming process goes on causing progressive loss of metal, resulting in a diminishing safety factor.

MANY RAILROAD MEN KNOW How To PREVENT THIS Loss

*.. When badly "INFECTED"
they lose weight and strength*

Many railroad maintenance men protect their steel bridges by treating them with NO-OX-ID.

If corrosion is causing loss of steel on your bridges, you certainly don't have to put up with it a minute longer. Use NO-OX-ID to stop rust and eliminate also the expense resulting from costly replacements of rusted-out members. Write for information.

DEARBORN CHEMICAL COMPANY
Dept. U, 310 S. Michigan Ave., Chicago
New York • Los Angeles • Toronto

NO-OX-ID
IRON-**OX**-RUST
TRADE MARK
the original rust preventive

OXY-ACETYLENE FLAME-CLEANING

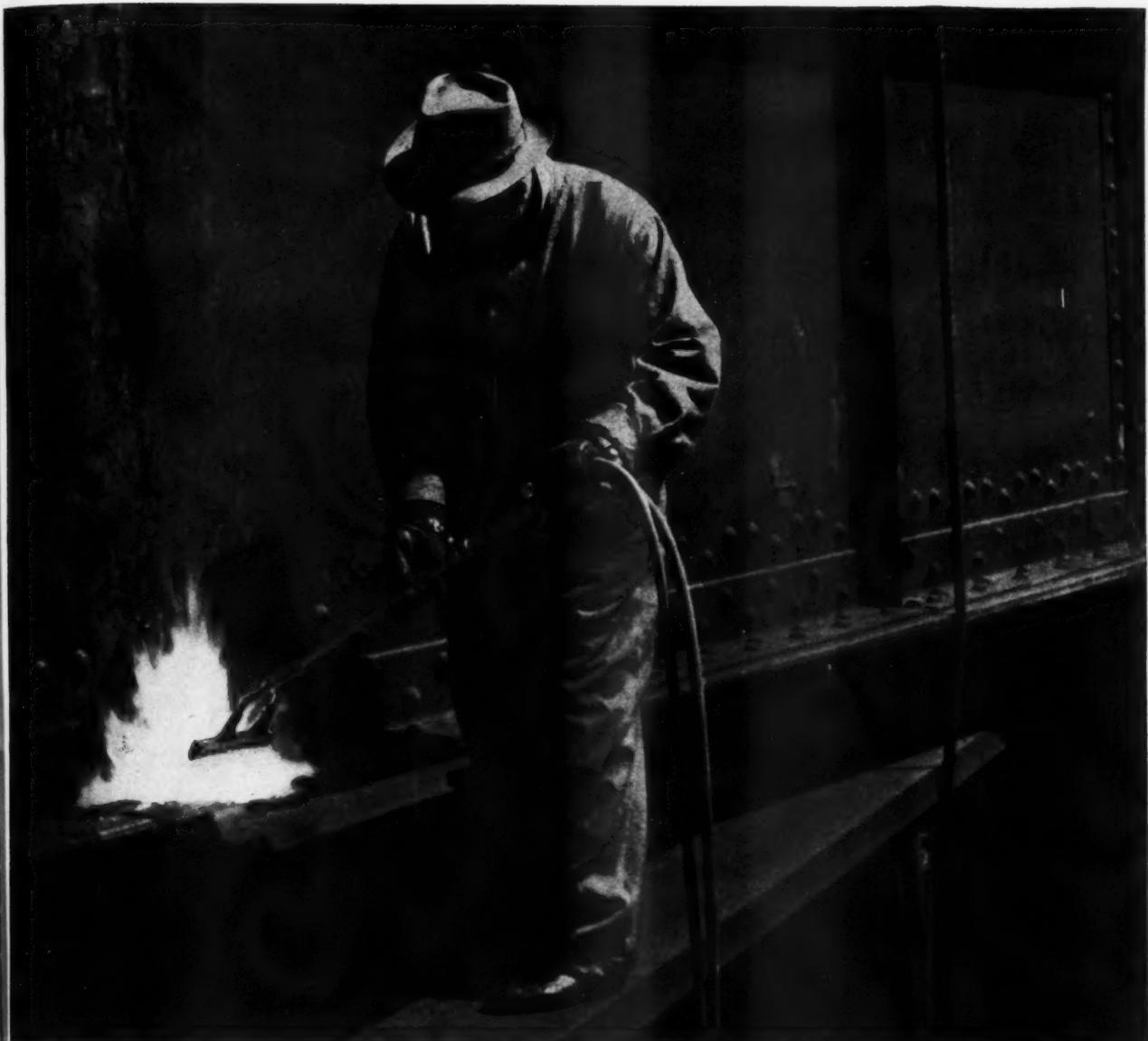
*Makes Paint Go On Faster
. . . . Bond Tighter
. . . and Last Longer*

OXY-ACETYLENE flame-cleaning with Oxweld equipment preparatory to the painting of bridges, tanks, cars, coaches, and many other types of steel structures is being used increasingly. This effective procedure quickly removes loose paint, scale, and rust from steel surfaces, and at the same time drives out surface moisture. After the steel has been flame-cleaned and then wire-brushed, it should be painted immediately. The protective coating then spreads more evenly and quickly on the warm, dry surface, and a tighter bond is effected. As a result, the major causes of subsequent corrosion and paint flaking are eliminated. This procedure is used to advantage on new structures before the initial protective coating is applied, and also on structures that are being prepared for repainting.



In the illustration, the operator is using the new-type 8-inch Oxweld flame-cleaning head to prepare a bridge for repainting. Oxweld makes available to the railroads the equipment required for application of this procedure, and competent instructors to help assure its effective use.

SINCE 1912 — THE COMPLETE OXY-ACETYLENE

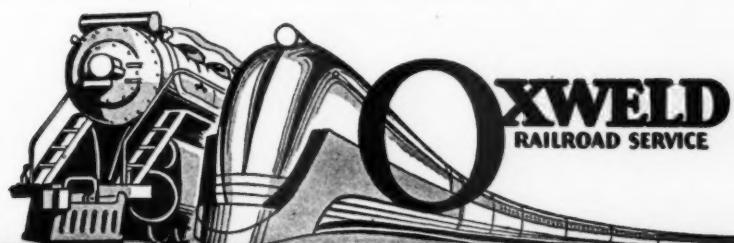


THE OXWELD RAILROAD SERVICE COMPANY

Unit of Union Carbide and Carbon Corporation



Carbide and Carbon Building Chicago and New York



S E R V I C E F O R A M E R I C A N R A I L R O A D S

To "git thar fustest with the mostest" * war trains need dependable track

You can keep your fast, heavy-duty track in condition with minimum use of critical materials and labor.

Pressure grouting of water pockets and soft spots in track with portland cement grout stiffens the sub-grade, keeps track in line and grade—reduces maintenance.

Track that needs little attention releases maintenance labor for other jobs. And track can be grouted without interference to operation—pressure grouting is done under traffic—there is seldom need for slow orders.

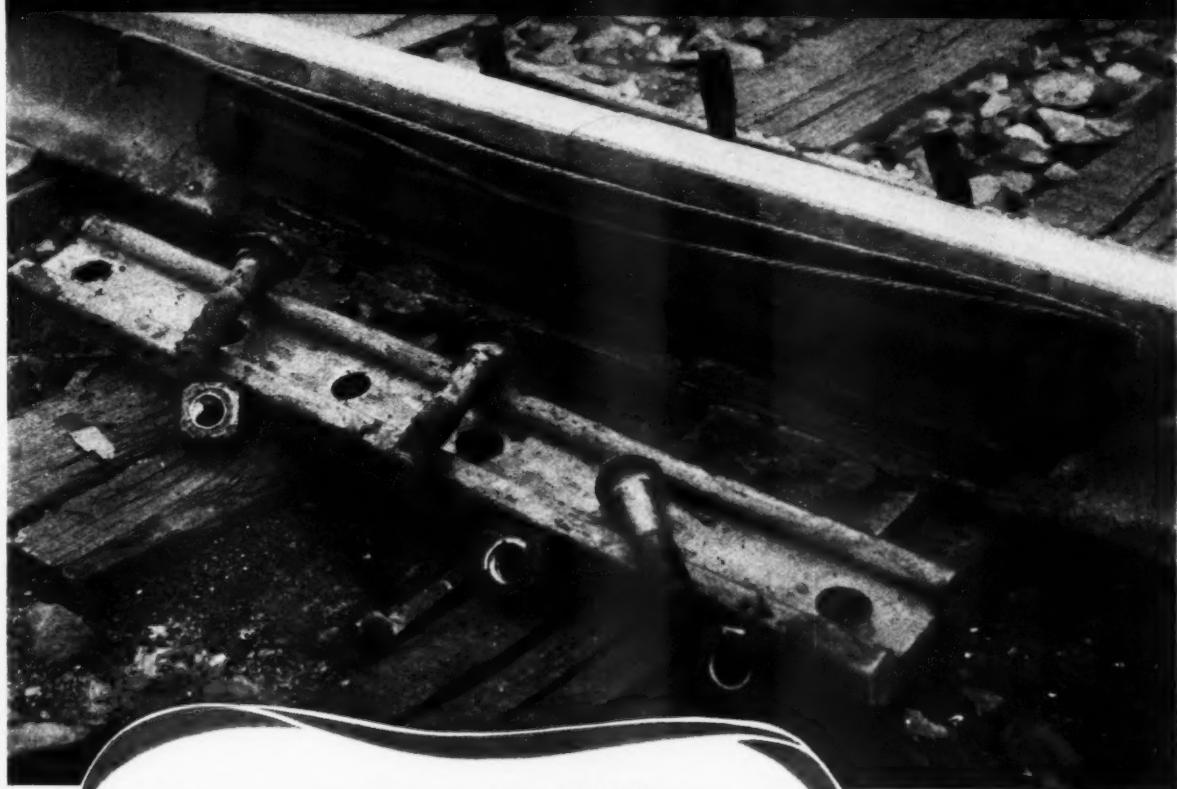
If you have soft track and water pocket conditions, pressure grouting may be your best solution. Ask us for further information.

PORTLAND CEMENT ASSOCIATION

Dept. 11-27, 33 W. Grand Ave., Chicago, Ill.

*CONFEDERATE GENERAL NATHAN B. FORREST'S SUCCESS FORMULA FOR WINNING BATTLES

SAVE STEEL FOR VICTORY!



**Conserve Your Rail With
RMC PLASTIC
and Serve the Nation!**

This splice was removed four years after packing with R M C Plastic. Note how completely free rail joint, bar, bolts and nuts are from corrosion.

Foresighted railway management now is doing everything possible to conserve the steel already in service, making it last, so that a maximum of new steel can go into America's war effort.

Preventing destruction of steel by corrosion is one effective way to conserve this vital material. **R M C PLASTIC** has proved its mettle in protecting thousands of miles of rail against the corrosive action of brine drip, water, ash and other corrosive agencies during the entire rail life. When **R M C PLASTIC** is packed solidly into every section of the joint assembly it thoroughly protects the fishing surfaces, shanks and threads of nuts and bolts, permitting proper rail expansion and contraction, eliminating frozen joints due to corrosion, and reducing the danger of kinks and humps in the track.



**RAILWAY MAINTENANCE CORP.
PITTSBURGH,**

PENNSYLVANIA



Verona Fixed Tension Triflex Spring

Provides

An Accurate Means of Establishing
High Practical Track Bolt Tension

Plus +

An Accurate Means of Establishing
Equal Tension in Each Bolt

Plus +

A Spring Reaction More
Than $2\frac{1}{2}$ Times A.R.E.A.
Specification Requirements

WOODINGS-VERONA TOOL WORKS



Since 1873

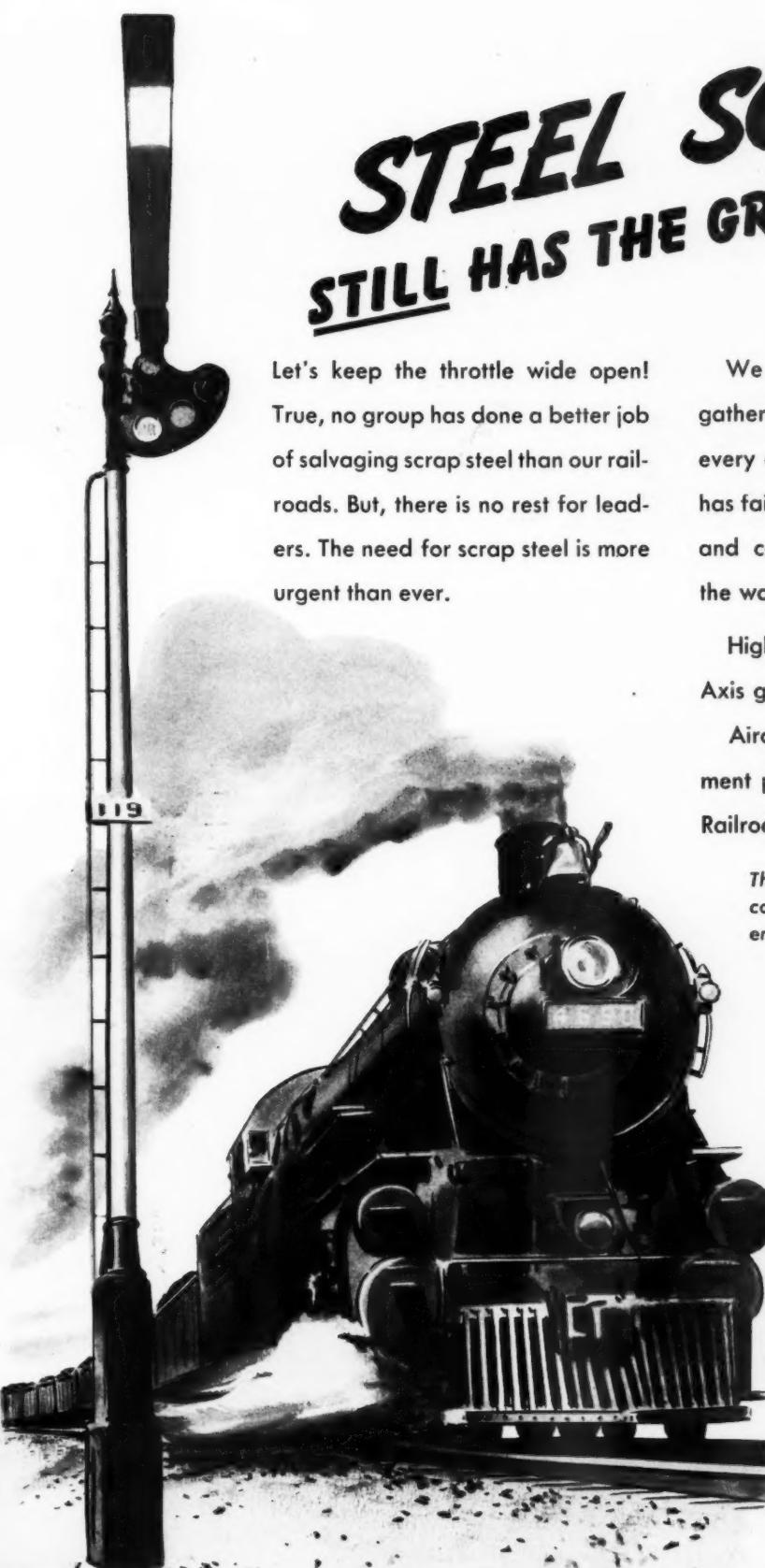
VERONA, PA.

CHICAGO, ILL.

Branch Offices Principal Cities

STEEL SCRAP

STILL HAS THE GREEN LIGHT!



Let's keep the throttle wide open! True, no group has done a better job of salvaging scrap steel than our railroads. But, there is no rest for leaders. The need for scrap steel is more urgent than ever.

We must not, we will not, fail to gather and deliver to our furnaces every available pound. The country has faith in our railroads' willingness and capacity to keep on leading the way.

High-ball the scrap along until the Axis gets tired of scrapping.

Airco gases and cutting equipment play an important part in the Railroad's scrap collection drive.

This advertisement contributed in cooperation with the U. S. Government Salvage Campaign by:



General Offices:

60 EAST 42nd STREET, NEW YORK, N.Y.

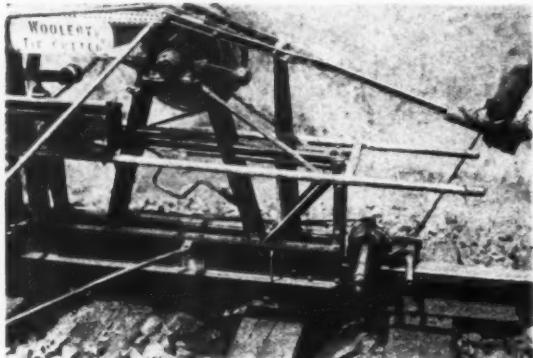
In Texas:

Magnolia-Airco Gas Products Co.
General Offices: HOUSTON, TEXAS
OFFICES IN ALL PRINCIPAL CITIES

OXYGEN IS PRODUCTION: DON'T WASTE IT!

Prepare Now for 1943 Labor Shortage

HERE ARE TWO GOOD WAYS TO DO IT!



With the Woolery Tie Cutter, shown at the left, trenching is eliminated and surfacing is reduced one-half.

WOOLERY TIE CUTTERS

Work Effectively in Stone, Gravel, or Other Types of Ballast

With traffic increasing steadily and the available supply of labor diminishing rapidly, 1943 is certain to bring serious track upkeep problems to railroad maintenance officers.

The Woolery Tie Cutter is the most outstanding development yet made for the renewal of ties. It simplifies the job. You get away

from the old back-breaking method, at the same time making a substantial saving with the use of these machines.

The Tie Cutter cuts the ties in 3 pieces which are quickly and easily removed with minimum disturbance to ballast. Trenching is eliminated; follow-up surfacing is reduced 50% and the new ties rest on firm solid beds without creating the usual soft spots.

With Woolery Tie Cutters on the job, you can be sure of completing your next year's tie-renewal program in less time, with less labor, releasing essential manpower for other tasks.

WOOLERY WEED BURNERS

More than 60 roads are now using Woolery Weed Burners . . . convincing proof of their efficient, economical performance in removing weeds from the track.

To handle successfully next year's record traffic, tracks must be kept in first-class shape . . . free of weeds and their harmful effects. You can eradicate weeds quickly, thoroughly and economically with Woolery Weed Burners, and also use them in the Winter to melt snow and ice from switches and interlockings. Woolery Burners are available in 5-burner, 3-burner, 2-burner and 1-burner models.



Above: 5-burner Giant Octopus Model. 3-burner, 2-burner and 1-burner Models are also available.

Insure Protection NOW by Putting these Units in Your 1943 Budget!

WOOLERY MACHINE COMPANY
Minneapolis, Minnesota



Since
1930

The Railroads of Canada

have employed

Detector Cars of Sperry Rail Service

from the Atlantic to the Pacific

To Assure Maximum Rail Safety



SPERRY RAIL SERVICE • HOBOKEN, N. J. • CHICAGO, ILL.

FOR VICTORY TODAY AND SOUND BUSINESS TOMORROW



Get This Flag Flying Now!

This War Savings Flag which flies today over companies, large and small, all across the land means *business*. It means, first, that 10% of the company's gross pay roll is being invested in War Bonds by the workers voluntarily.

It also means that the employees of all these companies are doing their part for Victory . . . by helping to buy the guns, tanks, and planes that America and her allies *must* have to win.

It means that billions of dollars are being diverted from "bidding" for the constantly shrinking stock of goods available, thus putting a brake on inflation. And it means that billions of dollars will be held in readiness for post-war readjustment.

Think what 10% of the national income, saved in War Bonds now, month after month, can buy when the war ends!

For Victory today . . . and prosperity *tomorrow*, keep the War Bond Pay-roll Savings Plan rolling in *your* firm. Get that flag flying now! Your State War Savings Staff Administrator will gladly explain how you may do so.

If your firm has not already installed the Pay-roll Savings Plan, *now is the time to do so*. For full details, plus samples of result-getting literature and promotional helps, write or wire: War Savings Staff, Section F, Treasury Department, 709 Twelfth Street NW, Washington, D. C.



**Save With
War Savings Bonds**

This Space Is a Contribution to America's All-Out War Program by

RAILWAY ENGINEERING AND MAINTENANCE



*It Is Time To Think of
Your 1943 Requirements*

BARCO
Unit Tytampers

Do A Better Job Quicker In Out Of Face Or Spot Tamping At Lower First Cost . . . Lower Maintenance Cost.

89 RAILROADS USING BARCO

Seven Years Satisfactory Service

BARCO MANUFACTURING CO.

NOT INCORPORATED

1805 W. Winnemac Ave.

Chicago, Ill.

IN CANADA

THE HOLDEN COMPANY, Ltd.

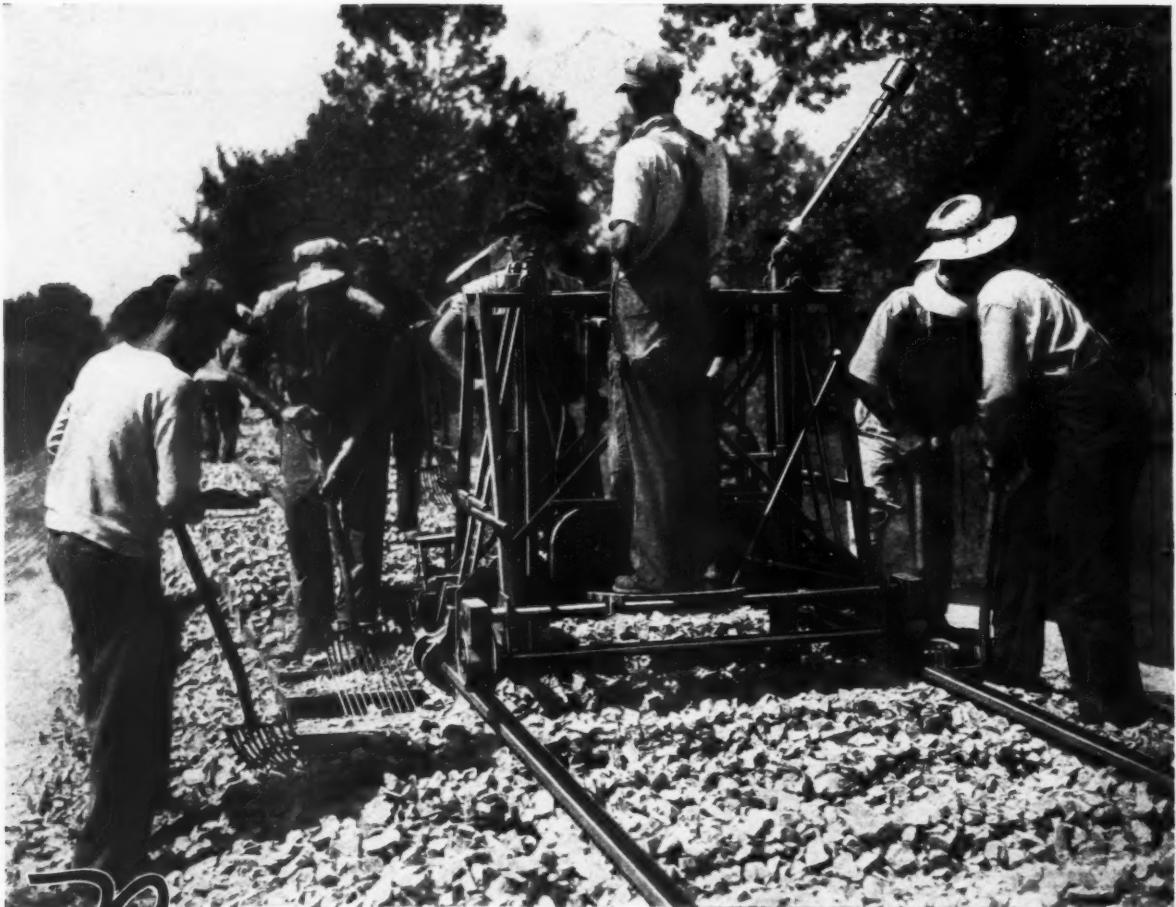
Montreal - Moncton - Toronto - Winnipeg - Vancouver



Spot tamping at busy terminals and crossings is quickly and easily handled—no auxiliary equipment in the way.



BARCO Tytampers may also be operated from a small light-weight central power plant for out of face tamping, as shown above. This unit, weighing less than 100 lb., and costing less than \$100, is supplying power to 12 BARCO Tytampers.



Raise track the hydraulic way

With the development of the Nordberg Hydraulic Power Jack, another outstanding contribution was made to the extensive line of power driven tools Nordberg has introduced for the maintenance of track.

NORDBERG POWER TOOLS FOR TRACK MAINTENANCE

Power Jack
Spike Puller
Adzing Machine
Rail Drill
Power Wrench
Surface Grinder
Utility Grinder
Midget Grinder
Track Shifter

Those not accustomed to using the Power Jack or those familiar with the older screw jack model will be amazed at the smooth, powerful action of the hydraulic thrust cylinders, ease of handling, simple controls, accuracy of lift and light weight. It weighs less than half as much as the previous model. If you have a ballasting or surfacing job, do it the hydraulic way. You will do the job faster and at less cost with a Nordberg Power Jack.



NORDBERG MFG. CO. MILWAUKEE, WISCONSIN

Export Representative—WONHAM Inc.—44 Whitehall St., New York



Today . . . more Fairmont Motor Cars are working on the railroads of America than all other makes combined. That fact alone tells you more about the dependability, the economy and the overall efficiency of Fairmont Motor Cars than anything we could tell you. This universal acceptance is the result of more than thirty-two years of cooperation and service, in the field, with the men who use the cars daily. The Fairmont line includes the most complete selection of railway motor cars and offers many advantages, such as, standardization of major parts and the traditional Fairmont time-proved features—water cooling, endless cord belt transmission, demountable wheels, easy accessibility of parts, and others of equal importance. You will find our Bulletin No. 471 a valuable, quick motor car reference book for your desk. Send us your name and address and we'll mail your copy at once. Fairmont Railway Motors, Inc., Fairmont, Minnesota.

Fairmont

Performance
ON THE JOB
COUNTS

RAILWAY MOTOR CARS

OF ALL THE CARS IN SERVICE TODAY . . . MORE THAN HALF ARE FAIRMONTS

CP TOOLS EXPEDITE BRIDGE MAINTENANCE



↑ FOR BRIDGE REPAIR and maintenance the CP Boyer Riveting Hammers, capacities $\frac{5}{8}$ " to $1\frac{1}{4}$ ", are especially recommended. Light weight, minimum length, rapidity and power of blow, smoothness of operation, ease of control, instant stopping and starting, long life, low upkeep . . . these are characteristic features that have made CP Boyer Riveting Hammers favorites with maintenance men for over forty years.



↑ BUSTING 3/4" RIVETS on replacement of worn and corroded steel in closed deck railroad bridge with No. 81-X CP Boyer Rivet Buster. Fast, efficient, ideal for use in close quarters, this tool saves time and labor.



↑ SCALING RUST from steel top plate and trough of closed deck railroad bridge with CP V-2 Scaling Hammer. This sturdy, compact, efficient tool is excellent for general scaling purposes.

RIVETERS, RIVET BUSTERS, SCALING HAMMERS AND WOOD BORERS STEP UP REPAIRS

New Men Take To Them Quickly

CHICAGO (CP) — With vital wartime maintenance problems the chief topic of the 49th Annual Meeting of The American Railway Bridge and Building Association, wide interest is noted in the time and labor savings effected by CP Pneumatic Tools.

For bridge repair and maintenance there are five sizes of CP Boyer Riveting Hammers, with capacities for rivets from $\frac{5}{8}$ " to $1\frac{1}{4}$ ". For busting rivet heads, CP 11-X (1" capacity) and CP 81-X Boyer Rivet Busters are fast and easily handled by one man. For removing rust, scale, old paint, or soot from metal surfaces, CP Pneumatic Scalers are invaluable. Fast, efficient, and easily handled, CP Pneumatic Wood Borers soon pay for themselves in time and labor saved.

CHICAGO PNEUMATIC
TOOL CO. COMPANY

General Offices: 8 E. 44th St., New York, N. Y.



↑ BORING SPIKE HOLES in ties, in bridge and trestle timber, and other wood boring jobs encountered in bridge repair and maintenance work, are speeded by the use of fast, efficient CP Pneumatic Wood Borers.

CHICAGO

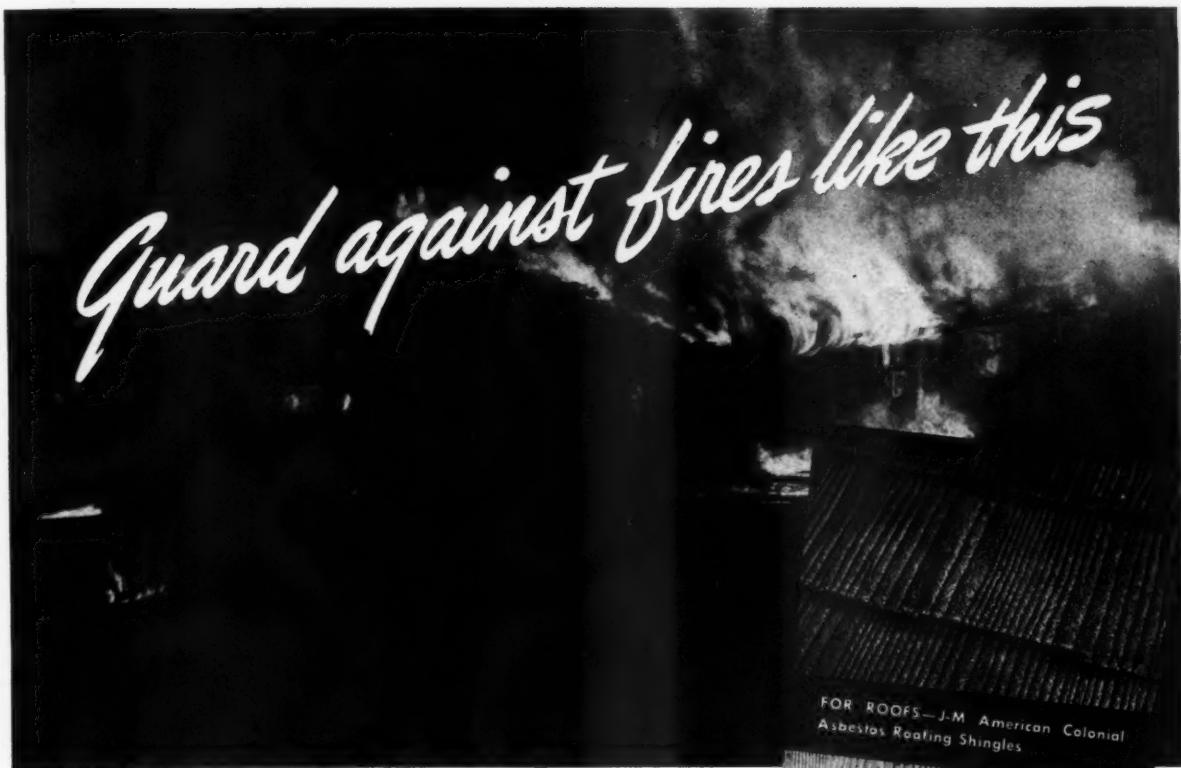


PNEUMATIC

PNEUMATIC TOOLS

ALSO: Air Compressors, Electric Tools, Rock Drills, Hydraulic Aviation Accessories, Diesel Engines

DRILLS
WRENCHES
SCREW DRIVERS
RIVETERS
GRINDERS

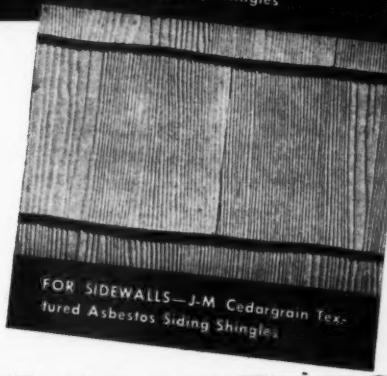


**by applying
J-M ASBESTOS SHINGLES
on ROOFS and SIDEWALLS**

**Fireproof, attractive, require
practically no maintenance**

Old or new buildings can be given the extra fire-safety of J-M Asbestos Shingles at low cost. Made from a composition of asbestos and cement they are rotproof, weatherproof and permanent as stone—need no preservative treatment.

For details on the use of J-M Asbestos Shingles on your stations, shops and sheds, write Johns-Manville at New York, Chicago, Cleveland, St. Louis or San Francisco.



THIS IS A TYPICAL STATION, protected against fire, weather and wear with J-M Asbestos Shingles.

JOHNS-MANVILLE
84 YEARS OF SERVICE TO TRANSPORTATION

No. 167 of a series

Railway Engineering and Maintenance

SIMMONS-BOARDMAN PUBLISHING CORPORATION

105 WEST ADAMS ST.
CHICAGO, ILL.

Subject: Minute Man Flags

November 1, 1942

Dear Reader:

In these days when railways whose employees are participating so universally in the purchase of war savings bonds are receiving merited recognition therefor from our government, I assume that you have observed, as I have, that the engineering and maintenance of way department invariably leads other major departments in the percentage of employees participating. This action reflects the inherent loyalty that is so characteristic of this group of employees—whether called into play to combat a local blizzard or washout or to meet a national emergency such as that through which we are now passing. Their loyalty is all the more striking when contrasted with the records made by the employees of certain other departments that have claimed for themselves superiority in the past.

It is very fitting that a means has been devised for recognizing the loyal support of the employees of a railway through the award of a Minute Man flag. I am sure that you agree that it would be still more heartening to maintenance of way employees if their leadership in this direction could be recognized still further by the award of a departmental flag.

The days through which we are passing are difficult for maintenance of way men—with the necessity for maintaining their tracks and structures for the heaviest and most exacting traffic in history—in the face of insufficient supplies of much-needed materials, heavy turnover in forces, etc. Yet the same spirit that prompts their wholehearted co-operation in the purchase of war savings bonds is spurring them on to similar efforts to overcome the difficulties in the upkeep of the properties under their care in order that the tanks, the shells and the planes will not be "too few and too late" in the support of their sons who are now at the front.

And while commenting on the award of Minute Man flags to individual railways, we of the staff of Railway Engineering and Maintenance are proud of the fact that we also display a Minute Man flag that was awarded us last April in recognition of the fact that 100 per cent of our staff in Chicago is participating in the purchase of these bonds.

Yours sincerely,

Elmer T. Hanson

Editor

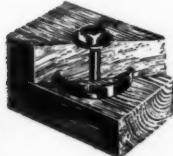
ETH:GP

...Have you?

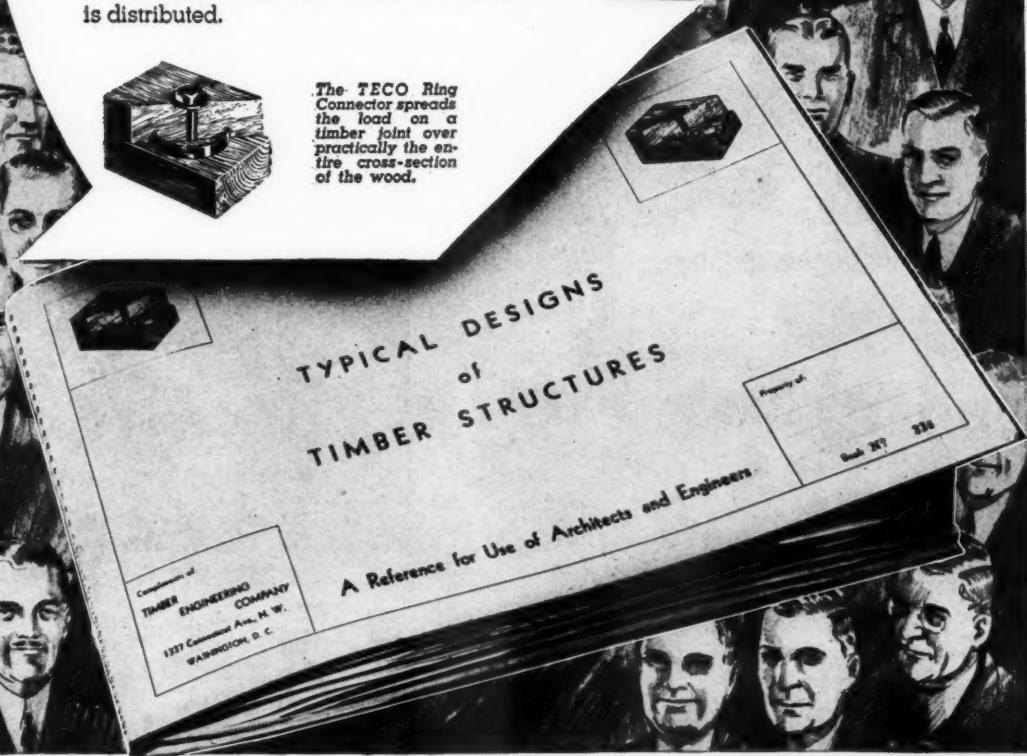
If not, you still can get your copy of *Typical Designs of Timber Structures* by writing us on your professional letterhead.

Plans of 45 representative types of timber structures are included. You will be interested in the wide range of structural possibilities featured, as created under the TECO System of timber construction; also in TECO's savings of time, materials, and money.

Write us now . . . before the present supply
is distributed.



The TECO Ring Connector spreads the load on a timber joint over practically the entire cross-section of the wood.



Timber ENGINEERING COMPANY

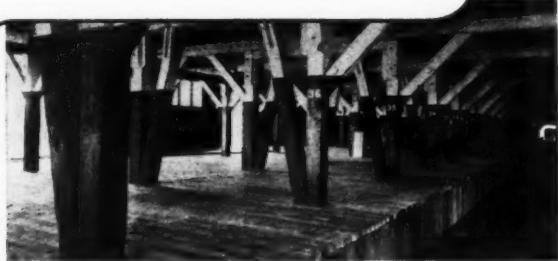
Peace-time performance of Wolmanized timber spotlights its war-time value

The war-time need for speed in construction and dependability in materials has focused attention on timber as never before. And engineers who are looking to *treated* timber are impressed by the service records established by the more than 300,000,000 feet of *Wolmanized* timber installed over the past eighteen years.

Clean, odorless, paintable...without added fire hazard...lumber and timber pressure-treated with Wolman Salts preservative is being used by the railways in bridges and trestles, shops and engine houses, coaling bins and water tanks, warehouses and freight stations, passenger stations, and a score more types of railway structures.



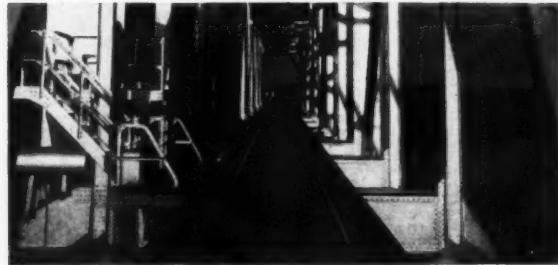
All this trestle material was fabricated before treatment



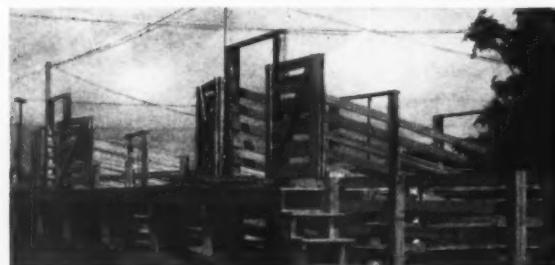
Wolmanized black gum decking hardens under traffic



Wolmanized engine house trusses save steel, last longer



Wolmanizing adds no fire hazard, keeps weight down



Wolmanized Lumber is widely used for accessory structures



Cleanliness is important in city street crossovers



This dock and ore-loader are seven years old



Railway Engineering and Maintenance

NAME REGISTERED U. S. PATENT OFFICE



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NOVEMBER, 1942

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ELMER T. HOWSON

Editor

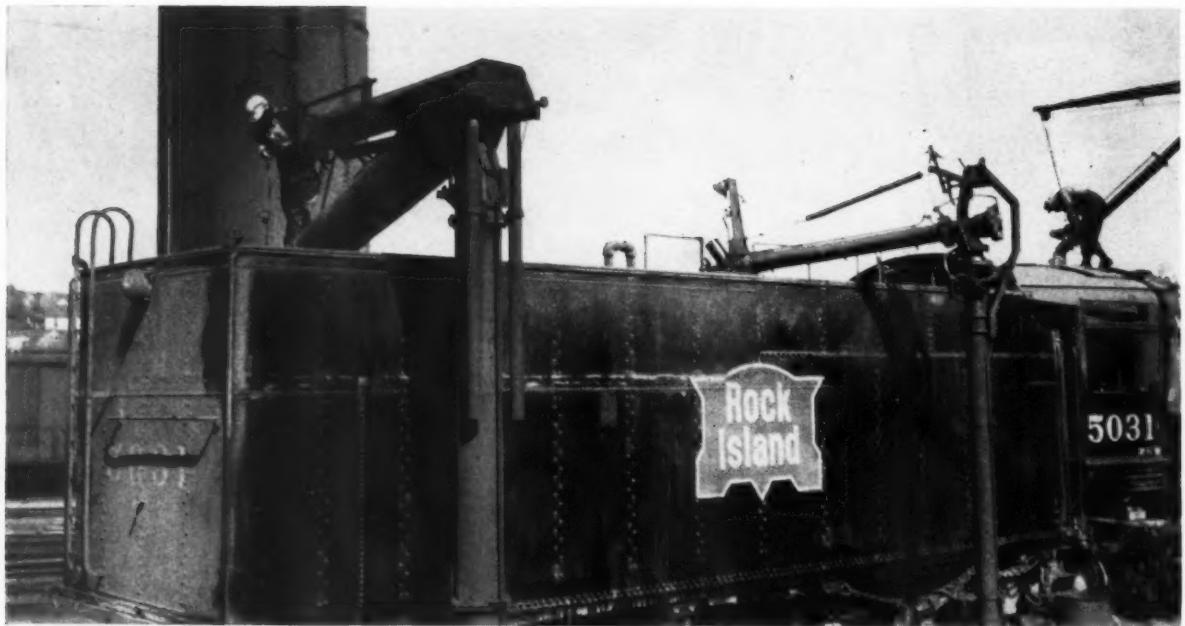
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Business Manager



WHEN MANPOWER IS SCARCE

Performance is doubly important!

New SNOCO Hi-Speed Watering, Sanding and Fuel Oil Servicing Facilities Are Proving BIG Aid to Rock Island's War Effort!

A Battery of eight SNOCO Locomotive Servicing Spouts, at the new Facility at Armordale Yards, Kansas City, Mo., is setting records for speed, volume and efficiency.

Stabilized Water Spouts, Telescopic Fuel Oil Cranes and many other ingenious SNOCO devices, enable the simultaneous servicing on three tracks of the smallest switch engine to the largest road engine.

SNOCO Locomotive Servicing Facilities can help you too in your effort to speed train service and we shall be happy to make suggestions to meet your particular requirements.

SNOCO

SPOUT PERFORMANCE

Newly designed fixtures give much greater range for all classes of engines provide more flexibility and speed; eliminate close spotting.

T. W. SNOW CONSTRUCTION CO.
9 SOUTH CLINTON ST.

CHICAGO, ILLINOIS

Railway Engineering and Maintenance



Two Wars

And Two Records of Service

We are now engaged in war. Twenty-five years ago we were engaged in a similar war, although on a smaller scale. Nine months after we entered the first World War, the government took over the railways and operated them until after the conclusion of hostilities. In this war, the railways have been left under the management of their owners and today, eleven months after hostilities began, there is no agitation to change this control. This contrast is of very direct interest and concern to every railway employee.

Comparing 1918 With 1942

In the first year after the government took over the railways, 1918, they handled only 12 per cent more freight and only 23 per cent more passenger traffic than in 1916. In contrast, in June, 1942, the railways rendered 80 per cent more freight service and 106 per cent more passenger service than in June, 1940, the month in which we began our preparations for war, and they handled this increased traffic with far greater satisfaction to the military forces and to the public.

And in rendering this service they are earning the largest net operating income in their history, except in 1929. In spite of the fact that revenue per ton mile and per passenger mile is now lower than in 1929, the gross earnings of the roads were \$200,000,000 larger in the first half of this year than in 1929. Furthermore, although wages are now 31 per cent higher than in 1929, the ratio of operating expenses to gross earnings was only 68.3 per cent as compared with 75 per cent in 1929. And although the railways paid \$291,000,000, or 150 per cent, more in taxes in this six-month's period of 1942 than in the same period in 1929—an increase largely exceeding the increase in gross earnings, their net operating increase was only \$11,000,000 less than in 1929.

Contrast Is Illuminating

This contrast between the results attained by the railways of the United States in two crises of similar nature but under different forms of management, is highly illuminating. It is worthy of analysis for it affords a striking example of the advantages of private enterprise in meeting new conditions.

The records that the railways are now making are not the result of accident or chance; rather they are the logical outgrowth of a deliberate policy. In the first place, they reflect the benefits accruing from a program of expansion of railway facilities that began in 1923 and that has involved the expenditure of some ten billion dollars of new money. They reflect also the beneficial results growing out of a carefully devised and developed plan for the promotion of more intimate cooperation on the part of shippers than had ever been attempted heretofore. And out of this has come the most efficient use of railway facilities that the United States has ever seen.

Such a record is of very real value to the American public, especially in a period of national emergency such as that through which we are now passing. It is of even more direct concern to those who, as employees, are devoting their lives to this industry, for as an industry prospers through efficient leadership, so do those employed in its service.

Winter Work—

More Must Be Planned This Year

MANY classes of maintenance of way work have long been considered seasonal, with little constructive activity during the winter months. In many parts of the country, generally adverse winter weather conditions, and an adequate supply of labor during the remainder of the year have tended to perpetuate this condition, in spite of certain recognized benefits to be derived through the greater stabilization of forces. However, in the light of present war conditions, which are calling for the heaviest work programs in more than a decade, the certain need for still larger programs as the war effort of the country is stepped up, and the strain that is being placed on the labor supply of the country, particularly during the late summer and fall months, it is essential that maintenance men review the entire question of seasonal work, and do this quickly, looking to utilizing the coming winter months for constructive work to the fullest extent possible.

In the boom days of the late Twenties, when the railroads were conducting the largest maintenance programs in their history, with concurrent heavy labor turnovers, if not shortages, the question of winter work came to the fore on many roads, and not a few enlarged their winter programs, not only getting much necessary work out of the way of essential spring and summer programs ahead, but materially stabilizing their forces, with large benefit in that respect. During the depression years, with reduced work programs and a surplus of labor, the urgency for winter work disappeared; in fact, many roads, due to depressed earnings, had difficulty in employing full-time forces even during the summer months, and only the barest skeleton organizations were maintained during the winter.

Now, facing conditions more stringent than ever experienced in this country, placing an unprecedented burden upon the fixed properties of the railways in the face of a growing shortage of labor that is already serious in many sections of the country, history is repeating itself. And again, maintenance men are being called upon, of necessity, to spread their increased operations more uniformly throughout the year, not alone to permit the completion of a greater volume of work, but to utilize labor when it is most readily available. This means enlarged winter programs, even at the expense in some territories of maximum efficiency as compared with work carried out during the warmer months of the year, and, in some areas, it means correspondingly reduced programs during the late summer and early fall months when the harvest calls for maximum manpower on the farms of the country.

Earlier this year, anticipating a labor shortage in the fall, Joseph B. Eastman, director of Defense Transportation, issued a statement directing attention to the fact that certain roads in a predominately agricultural area of the country were using more than 50 per cent more section and extra-gang labor during August, September, October and November than at any other time during the year—a period when the farm sections served by these roads have the greatest need for workers. In general, he pointed out, "The railroads are using the greatest number of maintenance of way workers when they are hardest to recruit, and the least number when they should be easiest

to recruit." Calling attention to the fact that mild winter weather prevails generally in the area to which he referred, Mr. Eastman urged the railroads involved to plan as much of their roadway and track work as possible during the winter, spring and early summer months, when farm demands are low.

If Mr. Eastman's admonitions earlier in the year were in order—and labor conditions of recent months have demonstrated that they were—it is still more important at the present time, and now applies to the railways over a much larger section of the country, if not to all of the railways. More winter work is the most effective answer to reduced peaks of maintenance work in the other periods of the year when the competition for labor is the greatest. If this is true, wise maintenance men, in the interest of their roads and their country, if not their own selfish requirements, will review their plans for the coming months with the idea of making them more productive of effective work than at any time in the past. This will present difficulties, and a re-orientation of thinking on the part of many, but who is not required to face difficulties and a re-orientation of his thinking and plans in these strenuous days?

Clean Ballast—

Its Importance Now Generally Recognized

WHEN the railroads began to feel the effects of the depression during the early "thirties," one of the first items of track work to be curtailed or eliminated on many railroads was the cleaning of ballast. At the time, this appeared to be a convenient means for effecting a drastic reduction in maintenance expenses. It did not exert an immediate effect on the safety of the track, and, moreover, since mechanized methods had not been widely adopted, the cleaning of ballast was a costly procedure.

This year the trend has been sharply reversed, for more ballast has been cleaned during 1942 than in any year during the last decade. In part, this increase in a type of work that has been so long neglected on many roads is a step in the general expansion of maintenance activities that has been so strongly in evidence this year. However, to dismiss the matter with this explanation would be to overlook a number of interesting considerations.

Many roads have had ample opportunity in recent years to study the consequences when track ballast—at least that in the shoulders and inter-track spaces—is not cleaned periodically. Maintenance men have found that it is extremely difficult and costly to maintain track to the standards required today if the ballast is foul or cemented. One of the most difficult aspects of the problem is presented when water becomes trapped in such ballast, resulting in pumping joints and frequently in a generally sloppy condition of the track. Today there are long stretches of main track on trunk-line railroads in which the ballast is so muddy as to indicate that a heavy rainstorm has just occurred, although this is belied by the dry condition of the side ditches and the surrounding countryside. This condition has perhaps been aggravated somewhat this year by the fact that the rainfall has been somewhat above the average in most parts of the country, but unusual precipitation has little effect on track in

which the ballast is sufficiently clean to permit surface water to drain off readily.

It is little wonder that the question has been raised whether it is wise to start by curtailing ballast cleaning when retrenchment becomes necessary, for it is now generally recognized that clean ballast is vital to economical track maintenance—that to keep ballast clean and in a condition to shed water readily is necessary if excessive expenditures for maintaining track to the proper line and surface are to be avoided.

Perhaps the more universal realization of the truth of this statement is prompting the present tendency to place more emphasis on ballast cleaning. Another factor is the more general adoption of mechanical methods of cleaning ballast—methods that have reduced the cost of doing the work to only a few cents per track foot. In any event, it is reasonable to expect that henceforth ballast cleaning will rank more generally as an essential phase of track maintenance, and that there will be less tendency to regard it as a non-essential activity that can be curtailed or eliminated with comparative impunity.

Conservation—

Will Save Much Critical Material

MUCH is being said these days about the collection of scrap, which is needed so badly for the production of steel, and about the salvage, including both recovery and reclamation, of usable but unused materials. It is not debatable that both of these items are of urgent importance in the all-out war effort in which this nation is now engaged, or that the twin campaigns of collecting scrap and salvaging materials should be carried on constantly, intensively and with no relaxation. On the other hand, not so much is being said about the conservation of materials now in active service, although this may be of no less importance.

All materials are subject to deterioration through wear and weathering, but the rate at which this deterioration occurs can be accelerated by neglect or retarded by suitable means for preventing wear and for protection against the elements. A dry bearing on a power machine, a power-operated tool or a motor car may cause damage far greater than the cost of correct lubrication. Allowing a bridge to remain unpainted for only a short time may be far more expensive in the long run than to keep it painted so that corrosion cannot gain a foothold.

There are many other ways, in which the deterioration of materials and equipment is accelerated. Again, both materials and equipment are often abused. A crane is set at tasks beyond its capacity; a motor car is run for long distances at unreasonably high speeds; the valves on a pump are neglected until slippage is excessive; a motor is overloaded and burned out; track bolts are not retightened quickly after they become loose; defective gage or line is not corrected when it first develops; door hinges are allowed to remain loose or door checks out of adjustment; and damage is certain to ensue, some of which may be difficult or impossible to repair. In the past, the ease with which materials and parts could be obtained for replacement purposes has tended, in many instances, to reduce scrutiny of the care given to

prolong the life of materials and equipment in service.

Today it is not easy to justify requests for many materials, particularly those needed for war production; and others are scarce because the war effort is interfering with their production. For these reasons, unusual effort should be exerted to prolong the life of materials in service, not only to reduce civilian demands for critical materials, but to avoid adding to the scarcity of others that are needed for civilian purposes. While measures to curtail abuses of materials and equipment, and to reduce normal wear and deterioration, are not dramatic or spectacular, they should not be dismissed as of no consequence, for what is saved in this way does not have to be purchased and thereby reduce supplies of critical materials that are already insufficient to meet all needs.

Foremen—

Guardians of Our War Traffic

THE railways are making a remarkable record for service and efficiency, outstripping all previous achievements in either war or peace. Never before in their history have they produced so many ton-miles as in recent months; never before have they operated with greater speed and dependability. Such performance, so essential to the nation's war effort, is today receiving increased recognition by the public, the army, and government officials. Unfortunately, however, what is being said so often seems so impersonal—commending a great industry as such, seemingly forgetful of the fact that behind these achievements, and the controlling factor in most of them, is a vast body of workers, toiling more intensively and conscientiously than ever before.

It is true that the locomotive engineer, so closely associated with the most dynamic and colorful aspect of railroading, the locomotive, has received some recognition for his important contribution, but there are others, thousands of them, far from the public eye, who are doing their part just as loyally and faithfully as any locomotive engineer, and with increased energy and vigilance during these days of new problems and responsibilities. Outstanding among these are the maintenance foremen—guardians of the tracks and structures night and day—in fair weather and foul; the first on the job in the morning and the last to leave at night, and subject to call at any hour. When danger threatens, no matter what the hour or weather, it is the foreman who strikes out, afoot or on motor car, to insure the integrity of his tracks and structures. Never before were alert, energetic and loyal foremen more indispensable to the railways, for today nearly all of their many duties have been enlarged or have become more important as the result of the war effort of the railways and the country.

Maintenance foremen require no acclaim for carrying out their duties faithfully. Every train safely over their territories, carrying troops, tanks, airplanes or any of a thousand of other war materials, is a source of satisfaction that they are doing their part, and a further incentive to "keep 'em rolling." However, those who today hail the achievements of the railways should not forget that it is largely through the energy and loyalty of such employees that these achievements are possible.



Railway

Supply Companies

Through

The Railway Supply Industry Is Playing an Important Part in Conserving War-Critical Materials

IN THE all-out effort of the country to speed war production and to conserve war-critical materials, and in the equally important all-out effort of the maintenance of way forces of the railways to keep war traffic rolling on safe and dependable tracks, the railway supply industry is playing a highly important part. To an extent far greater than is known or appreciated generally, this industry has accepted large responsibility—first, in the production of actual war materials, and second, in the continued production of those materials and units of equipment essential to adequate maintenance of the railways, employing a minimum of critical materials.

One year ago, few companies supplying railroad requirements had any part in actual war production. Today, there are many such companies wherein such production forms the major part of their output. One year ago, such companies, in their production of railway supplies and equipment, had unrestricted access to the seemingly abundant raw materials of the country, and their quantity and quality of output were limited only by the needs of the railways and limits in technological developments. Today, the production of many of these companies is affected on nearly every hand by priorities on materials, which not only restrict the availability of

many materials, but cut off others completely. To continue to produce railway products of the highest quality, therefore, to meet the stringent requirements of railway service, has presented a serious problem, but, through ingenuity and skill in engineering and design, this problem is being solved to an outstanding degree—accomplishing the all-essential purpose of conserving critical materials for the direct war effort, while, at the same time, affording the railroads their essential requirements.

Motor Car Manufacturers Hit

What many companies supplying the railways have already accomplished through this latter means to conserve rubber, structural steel, alloy steel, aluminum, brass, copper and other scarce ferrous and non-ferrous materials, is a long and detailed story, which cannot be told here. It is sufficient to say that their contribution in this regard has been most substantial, and to cite several examples, as largely typical, of what the industry is contributing. Outstanding among these examples, especially because of the exclusively railroad-type of equipment manufactured, is the motor car branch of the industry.

Track motor cars in their various types and capacities have long been

recognized as among the most important units of equipment employed by the maintenance of way forces of the railways. They provide an essential means of transportation for men and materials to and from their work, are indispensable in reaching points over the line in cases of emergency, and solve the inspection problems of officers and supervisory forces. For all of these purposes they must be powerful, strong, dependable, safe and comfortable, with minimum weight to permit their ready handling onto and from the track.

To these ends, motor car manufacturers have bent their efforts for years, and they have made remarkable strides. Prior to the inauguration of our National Defense program, materials, as such, were available in any quantity desired, and their availability presented no problem. Only questions of practicability, ingenuity and sound engineering principles dictated or controlled the materials that were used. Improvements in engine, frame and body design were almost as frequent as in passenger automobiles, in the interest of greater strength, efficiency, dependability, safety, comfort and lighter weight. The "sky was the limit" insofar as materials were concerned, and the various manufacturers made the most of it. In this era, steel replaced wood in many parts,

Save Critical Materials

Redesign and Substitution

Motor Car, Tractor, and Other Manufacturers Obtain Striking Results with Few Disadvantages to Equipment Users

and, in turn, was replaced with aluminum, rubber, steel alloys, copper and brass in many other parts. In fact, changes from one kind of material to another became commonplace and were expected in order to lighten weight and improve performance, and to increase safety and ease of handling.

But following "Pearl Harbor," conditions changed, and the outlook for many materials has grown progressively darker. One by one certain materials became scarce and others became more scarce. Strictly war production took precedence, and the motor car manufacturers were faced with a dilemma—and not only the manufacturers, but the railways as well, not only as regards their essential needs for replacements of worn out units, but for repair and replacement parts as well, to keep their present equipment in operating condition. But the manufacturers have met the situation through redesign and engineering, have surmounted their most difficult problems, and while protecting the needs of the railways, are conserving the most critical materials in a very substantial way.

Fairmont Typical

To be more specific as to the problems encountered and the measures taken by motor car manufacturers, here is what Fairmont Railway Motors, Inc., Fairmont, Minn., faced, and, briefly, what it has done to keep its cars rolling. Prior to December, 1941, as the result of long experience, Fairmont cars included wood, high and low-carbon steel, aluminum, rubber, brass, copper, high-speed

bearings and heat-treated gears, not to mention many alloys employed in various parts.

When the war first began to change conditions in December, the situation did not look too serious in general, and for the Fairmont Company and its customers, in particular. It became evident at once that certain materials would soon become scarce and that others would not be available for use in motor car construction for the duration, but Fairmont, with a large corps of competent engineers, knew

Materials for Victory

No. 5 of a Series

The maintenance of way forces of the railways have a large and important part in conserving war-critical materials. Articles 1 to 4, inclusive, in this series have pointed out four ways in which these forces are contributing or can contribute further. This article tells something of what those supplying the maintenance forces are doing, not alone in conserving critical materials, but, at the same time, in co-operating with maintenance men in meeting their essential requirements

that it could design a complete new line of motor cars without, or with minimum use of, critical materials. Furthermore, it had an exceptionally large stock of parts on hand, which was not only adequate for immediate demands, but which would allow ample time to design, test and produce the new line of cars.

That possible line of procedure of-



Left — The Fairmont 1-to-4-Man Inspection Car, in which a Saving of Approximately 127 Lb. of Aluminum Has Been Effectuated



Right—Large Savings in Aluminum and Other Critical Materials Have Been Effectuated in Other Fairmont Models Without Appreciable Increase in Weight

fered a solution—but there were many other factors to be taken into consideration. What about the railroad stores stocks on hand, if complete changes in design were made? What about the thousands of cars in service requiring repairs from time to time, if design changes in replacement parts were made?

Interchangeability of Parts Asked

Feeling that the railroads were entitled to express themselves on these matters, since they would ultimately be affected, the company made a quick survey of their views by asking various maintenance officers the following very pertinent question: "When substitute materials are required to continue motor car production, would you prefer a complete new design of car, maintaining its present weight, or should the present design be continued with not more than 10 per cent increase in weight, with all new parts interchangeable with those on present equipment?"

In every case the answer was the same. "Maintain the present design. We will accept the slight weight increase but by all means keep all repair parts interchangeable with parts on our present equipment, and with those on cars to be produced during the war." That, then, was the objective to accomplish—and it is being accomplished.

At the present time, new parts or groups of parts for Fairmont cars are being made interchangeable with the original, so that their substitution entails very little, if any, hardship on the man in the field. In most cases, shortages of specific materials have been anticipated, and substitute parts have been designed and tested before there was actual need for them. This has enabled the company to maintain production, and also to keep shipments moving out to the railroads with little or no delay.

In many cases, more than one substitute has been developed, so that if the first or closest should become unavailable in the future, another is ready and can instantly go into production. In developing all substitutes, four factors have been kept constantly in mind: To make new parts interchangeable with old; to make them of equal service; to keep the weight as low as possible; and to improve them if that can be done.

Substitutes for Aluminum

Aluminum was the first vital, or critical material that confronted the company, and since Fairmont was one of the earliest and most consistent users of aluminum in motor cars,

many changes had to be made in its cars. In the case of aluminum frame members, substitute materials developed range from low alloy steel to structural steel. Where steel is used in this connection, holes are punched in the neutral axis of the member to lighten its weight without affecting its strength.

Aluminum pistons and connecting rods came in for a change. Fortunately, for about three years prior to the start of the war, the company had been working on a light-weight, heat-treated alloy iron piston and a light-weight steel connecting rod. When aluminum pistons are no longer available, therefore, it is in a position to furnish a very light-weight cast piston of Diesel piston alloy, with a light-weight steel connecting rod that



Electrical Equipment Manufacturers Have Minimized the Use of More Than One Hundred Materials Which Have Been Designated as Vital for War Purposes

can be used with either the aluminum piston or the new steel piston.

Aluminum wheel guards have been replaced with full-width pressed steel guards that are of comparable weight with the aluminum guards and step used formerly. The water jackets on inspection and light section cars, formerly of aluminum, are now made of pressed steel and welded construction, while copper condensers will soon be replaced by those made of steel.

Aluminum idler pulleys have been redesigned to a combination of welded steel and iron, with relatively light weight, and yet ample strength. In many other cases, the use of pressed steel and welded fabrication have been resorted to, while in still other instances, various parts have been redesigned and made of iron. What all this has meant in the conservation of aluminum is well illustrated in the company's 1-to-4-man inspection car alone, a car which, prior to the present emergency, contained more than 65 aluminum parts. Today, in the production of this car, 95 per cent of all aluminum has been replaced, effecting a saving of approximately 127 lb. of

this critical material on each motor car.

Plastics, too, have taken their place in Fairmont cars, and are relieving a number of critical materials. The timer block, carburetor check valves and differential axle connectors are now made of plastics, with highly satisfactory results.

All of these substitutions have been made while adhering to the admonition of railway maintenance men—"Maintain the present design. We will accept the slight weight increase, but by all means keep all repair parts interchangeable with the parts on our present equipment, and with those on cars to be produced during the war." At the same time, careful performance, production and stock records are being kept of all substitute parts, and these parts are furnished only when the original parts are not available. When the war is over and original materials again become available, the change back to former standards, as seems desirable, will be made with equal facility and lack of inconvenience to motor car owners.

Caterpillar Makes Large Savings

What Fairmont and other motor car manufacturers are doing, in the motor car field, other companies serving the railways are doing in other fields, and, in many cases, on a much larger scale as regards the quantity of critical materials involved, because of their larger volume of production. For example, the Caterpillar Tractor Company, Peoria, Ill., whose crawler-type tractors have found an indispensable place in railroad earth-handling operations, both construction and maintenance, not to mention other uses, estimates that through redesign and revised manufacturing practices, it will save more than 2,300,000 lb. of strategic materials in 1942, based on 1941 production levels. Assured savings will approximate 250 tons of nickel, 700 tons of copper, 100 tons of aluminum, 50 tons of chromium, 40 tons of crude rubber and 55,000 lb. of tin.

Among the pioneers in the adoption of the induction method of hardening steel, Caterpillar has extended this process from cylinder liners to final drive gears, heavy shafts, drawbar pins, push rods, accessory and other shafts. Formerly made of nickel steel and nickel-chromium steel, these parts are now made of carbon steel, hardened by the induction process. In one tractor model alone, the Caterpillar Diesel D-8, the largest built by the company, 50 tons of nickel per year went into the final drive gears prior to 1942. Today, these gears, of carbon steel, induction hardened, have no appreciable nickel content.

A new air-blast method of quenching now makes it possible to use plain carbon steel instead of chrome-vanadium steel in tractor sprocket hubs and steering clutch flanges; carbon-manganese steel has replaced carbon-chromium steel in crankshafts, effecting a saving of vital chromium.

Last year, 3,200,000 lb. of copper were used in radiators and oil coolers. A change of oil cooler tubes and fins from copper to steel, and the adoption of steel fins for radiator cores has already assured a savings of 1,250,000 lb. in 1942. If an all-steel radiator now being tested can be adopted, and if seamless steel tubing becomes available to replace copper and brass tubing, the use of copper in these units will be almost entirely eliminated.

Malleable iron and cast iron are now used in certain parts, formerly made of aluminum, saving 100 tons of this critical metal annually. The major remaining use of aluminum is for pistons, but even here secondary aluminum is being used as a result of efforts by the company and its dealers to reclaim worn pistons turned in for replacement. In the event that requirements for aluminum exceed its availability, the Caterpillar Company is prepared to use cast iron pistons, already proven satisfactory in tests.

The savings being made by the company in crude rubber is being achieved by eliminating rubber entirely from seat cushion material and by the use of reclaimed rubber in fan belts and radiator hose. Demands for tin have been lessened by a reduction in the thickness of babbitt bearings, through the use of a higher percentage of lead and a lower percentage of tin in solder, and by improvements in a process that removes scale from heat-treated parts.

Two objectives have guided the Caterpillar Company's program of critical material conservation: First, to carry to the farthest practical limit the elimination of critical materials from its products; and second, to avoid sacrifice in quality, or, in case of extreme necessity, to make the least possible sacrifice in quality.

Big Saving in Tire Rubber

Allied closely with the savings being made by Caterpillar and other tractor companies in critical materials, is the huge saving in tire rubber that is being made by R. G. LeTourneau, Inc., Peoria, Ill., manufacturer of heavy earth-moving equipment—equipment that is coming into use by the railways in both construction and roadway maintenance work. This company has devised a method of cutting down the crude rubber content of the huge tires employed on its

Large Savings in Critical Materials Have Been Made by Changes in Caterpillar Tractors and Le Tourneau Earth-Moving Equipment



carryall scrapers, which, for its own requirements, will effect a saving of 500,000 lb. of rubber a year. Subsequently adopted by the war production board as standard equipment for all types and makes of heavy grading equipment, it is estimated that the rubber saving in the grading equipment industry will amount to approximately 1,500,000 lb., annually.

In each case, for the 18-by-24 tires employed on the larger carryalls, and the 16-by-20, 10-by-20 and 8.25-by-20 tires used on smaller model carryalls, the rubber saving amounts to approximately 25 per cent of former requirements. In the case of the larger 18-by-24 tires, approximately 60 lb. of rubber will be saved in the casing, 7 lb. in the tube, and 3 lb. in the flap. All of the new tires have a tread thickness of $\frac{3}{4}$ in.

The saving in rubber being made, it is said, does not affect the load-carrying capacity of the tires, but will cut the estimated working life from 30,000 to 20,000 hr. Severe as this cut is, it is known, on the basis of tire records in the past, that the new tires will have a service life of five to ten years, depending upon the character of the service required.

Electrical Equipment Savings Large

In an entirely different field, and again, railway manufacturers only in part, yet vital in meeting specific needs of the railways, are the electrical manufacturers, which are also playing a most important role in the effort to conserve strategic materials. To the extent that most of their products are based inherently upon the use of many of the most critically scarce materials, the problems of these companies have been greatly magnified over those of other manufacturers. Yet, the very fact that their normal use of these materials has been so large, has offered them an almost unlimited field for conservation through redesign and substitution.

What has been done and continues to be done by these companies is typified by the efforts of the General

Electric Company, Schenectady, N.Y., to minimize the use of one hundred or more materials which have been designated as vital for war purposes, and, hence, not generally available for other needs. Prominent among these materials are aluminum, chromium, copper, magnesium, nickel, tin, tungsten, formaldehyde, shellac, mica and rubber, all of which have heretofore been used freely in General Electric design and production, but which now, by redesign and substitution, are used on a greatly restricted basis.

Among the foregoing materials, aluminum has witnessed one of the largest cuts in G-E products, cuts which began prior to the entry of the United States into the war, and which are now saving more than 6,000,000 lb. of this material annually over former requirements. Some of these reductions in aluminum consumption include 1,300,000 lb. in meter production, 550,000 lb. in industrial control gear, 200,000 lb. in lightning protective devices, and 165,000 lb. in switch-gear construction. By far the largest reductions in the use of aluminum have been made in structural members, enclosing cases, cast aluminum bases, bearing brackets, etc., but it is interesting to note that from 65 to 70 thousand pounds of aluminum were used in conjunction with such products in the form of aluminum paint and sheet stock for nameplates, both of which have been completely eliminated, the former by a gray lacquer, and the latter, mostly by zinc. The total saving of aluminum being achieved by eliminating its use in nameplates on all G-E apparatus is estimated at about 175 tons annually.

Among the remaining scarce materials listed in the foregoing, tin comes next to aluminum in respect to the quantity consumed by General Electric for structural uses. Its three main uses divide into tin-base bronzes, babbitts and solders. To date, much progress has been made in reducing the tin consumption in the latter classifications, although the company recognizes that the field of bronzes offers

(Continued on page 796)

Track Scrap—

Its Importance in Our National

By B. C. Bertram

Director of Railway Salvage
War Production Board, Washington, D. C.



THE Conservation division of the War Production Board is composed of four sections, one of which is the Industrial Salvage section. Within this section there are four salvage directors for the four major industries—utilities, petroleum, mining and railroads. When I went to Washington six months ago, a desk was pointed out to me and I was told, "That is your desk, your job is to get the scrap off the railroads. Please go about devising a plan for bringing this about."

In following up this assignment, I first sought the advice of some men of wide experience, including several railroad presidents, and later I submitted a proposed plan to them. I even went farther than that. I went to the Association of American Railroads and to the American Short Line Railroad Association, so that when I launched the plan, I was reasonably sure that it would be acceptable to railroad management; that it wouldn't be viewed as just a "crackpot" scheme. The plan wasn't launched in strict accordance with my original ideas. It was revamped considerably on the advice of men of wide experience, but today that plan is in full operation. You men have contributed your part to this program.

Sought Out Relay Rails

Early in my experience in Washington, I became aware, through meetings with the Army and Navy Munitions board, that there was a very definite neck in the bottle, and that was the inability to get a sufficient

In this address, the speaker, formerly on the Lehigh Valley, tells roadmasters at their annual meeting in Chicago, September 15-17, that railroad scrap is vital to our war effort, both because of its availability and its quality—and that the critical time is now. While commanding many roads for their wholehearted effort in uncovering scrap, he pointed out that other roads are showing less enthusiasm, unfairly holding down the record of the railways as a whole. This situation, he says, must be remedied

quantity of relaying rails. Advance knowledge of this serious situation caused us on June 1 to send out an urgent appeal to the managements of 865 railroads to survey their properties with a view to eliminating unnecessary guard rails and more than 2,000 armoured crossings, to the shortening and eliminating of side-tracks, and to the recovering of rails from unused tracks wherever found.

National Conferences

More important than this, we organized national rail conferences, which were held at five different points from coast to coast, covering the period from July 7 to July 16, inclusive, and at which this important message was carried directly to railroad managements. As a result of this effort, from January 1, 1942 to July 1, 1942, the railroads supplied approximately 50,000,000 lin. ft. of relaying rails. The needs of the Army, Navy and Maritime commission as of July 1 were still 40,000,000 lin. ft. in addition to this amount. It is now gratifying to report that of this additional amount, approximately 39,000,000 lin. ft., or 520,000 tons, have been allocated, and that for the last several weeks we have for the first time been ahead of the immediate Army and Navy requirements. The requirements reported as of July 1 have since grown to 54,000,000 lin. ft. We have,

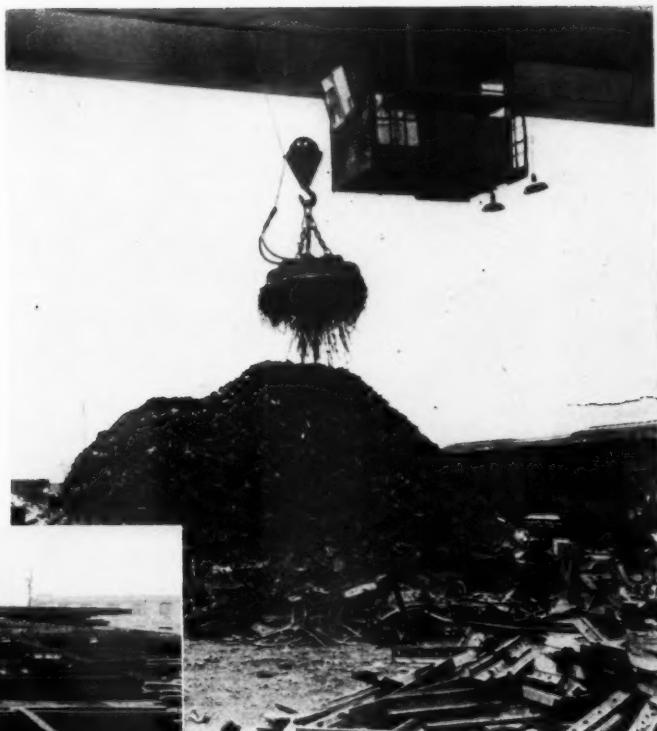
however, as a result of the efforts of the railroads of the country, no apprehension whatever as to our ability to furnish this additional amount, or more, if needed.

Railroad Scrap Vital

In Cleveland, Ohio, in April, a meeting, known as the Salvage clinic, was held. At this meeting, addresses were made by representatives of many of the big steel companies. In these addresses, it was brought out repeatedly that the handling of scrap on the railroads has always been an important function; that they have facilities for properly segregating this material; that railroad scrap is largely free from contamination; and that a good job of segregation has been done. Today, when there is a great need for the production of alloy steel—which is made entirely from scrap—railroad scrap is the most desirable of any type. The railroads are also one of the largest and most reliable sources of supply, so we find ourselves definitely in the forefront. In fact, the railroads contribute between 15 and 20 per cent of all the scrap that our nation digs up.

After being in Washington for a while, I began to realize the seriousness of the responsibility that had been placed upon me, and I want to tell you that I do not have a chance of living up to that obligation without the co-

War Program



The Railroads Are Among the Largest Producers of Scrap, and Their Scrap Is of the Most Desirable Type. It Must Be Kept Moving in to Help the War Effort

operation of every railroad man. I cannot tell you how to run your affairs, because I don't know how. You are skilled in your line and I, perhaps, know something about my particular line. All I can do is to show you the urgency, impress upon you, if I can, the seriousness of the situation, and appeal to you to do the job.

Not All Roads Co-operating

Not all railroads are inclined to become enthusiastic over this task. Many have, however, and are doing a bang-up job; but that is not enough. There are 865 chartered railroads in the country with whom I am carrying on correspondence, and any weak spot in that entire chain reflects on the railroads as a whole. In Washington, they don't ask me about the individual railroad; they ask me, "What are your railroads contributing?" I can't say, "Well, this railroad or that railroad, etc."—and it is not fair to you men on railroads that have done a bang-up job to allow other railroads to be delinquent in the performance of this duty; I am going to make it my responsibility to see that they don't. I

think I have every moral right to expect co-operation from every road.

There are many railroad men in the armed forces of our country. Surely, in this audience there must be men who have sons in this war. When such is the case, are we going to quibble about these matters?

The situation is merely this. The docks at tide-water are piled high with Lend-Lease and other materials badly needed over the world, awaiting ships that in many instances don't even exist. Now, we can't build those ships unless we have great shipways and their facilities, and in order to have these, we must have an endless supply of needed materials. How much of these materials can be supplied will be governed in large measure by the amount of scrap that you men go out and dig up.

There is also the matter of inventories, new materials and used materials. I understand that Jos. Eastman, director, Office of Defense Transportation, advocates the avoidance of waste of any piece of railroad material that might be reclaimed. That is fine, and I subscribe to that too, but if you are not going to use this material

within a reasonable length of time, the thing to do is to get it into the scrap pile.

The same is true of new materials. A survey that I made a couple of months ago indicated that many important railroads have supplies for only three, four or five months on hand, while other railroads have sixteen months supplies. Now it doesn't make a bit of difference whether it is your wife hoarding sugar or your railroad hoarding materials, it is hoarding, and don't forget that such hoarding may have helped bring about the shortages which made necessary the restrictive priorities that now harass the railroads.

Critical Time Now

Nothing can be gained by dodging an issue. Nothing will be of any constructive value but the plain facts placed in front of you so that you can look them in the face and decide what you are going to do about them. This hunt for scrap must go on indefinitely. The most critical time is deemed to be from now until the end of the year. After that, new blast

furnaces will be put into service that will relieve the scrap situation. We can, if necessary, use pig iron as a substitute for scrap. The great need is now, and the critical time will be in these winter months to follow. It was only a few days ago that my chief said to me, "Bertram, this winter we will have to rely on the railroads more than ever before, because it is only from the railroads that we will be able to get the scrap that will be needed during these winter months."

You are going to have to take organized labor into account. More and more it is demanding more representation on the War Production Board, and rightly so. After all, you are merely supervisors; you cannot go out and pick up the scrap yourselves. It is your men who must do it. Many of these men are members of the 22 railroad organizations. I have held meetings with these men on Capitol Hill to discuss plans whereby they may become an active partner in this scrap campaign. Co-operating with me is Alexander Whitney, who volunteered several months ago to have members of his Brotherhood of Railway Trainmen write letters to us giving the location of scrap. When I receive these reports in Washington, I have no way of knowing how legitimate the claims are, so I send them back for investigation to the emergency salvage directors that the railroads have appointed to co-operate with me in Washington.

Experience already has shown that in these tips on scrap, there are many duplications; yet the same experience shows that about 40 per cent really produce scrap, and we are not in a position to ignore them. When I send you reports that are sent to me in Washington, you men will have to be broad enough to consider them. If the information sounds foolish to you, brush it off; but if the reports point to scrap that you were not aware of, you will have to be big enough to say, "I didn't know that; I am glad to find out about it."

In other words, this is a war that doesn't belong to Mr. Roosevelt and doesn't belong to Mr. Nelson. It is your check and mine that they are taking a bite out of to help fight this war, and they are going to keep right on taking it out until this war is won.

In the near future, one of the biggest salvage campaigns that the world has ever known will be launched. It will be designed to reach into the home and the farm, and it will be patterned after the job that was done in Nebraska, which resulted in a return of, I believe, 104 lb. of scrap per capita.

I am frequently asked, as I was one time by a railroad officer, "Now, wait a minute, Bertram. I realize the seri-

ousness of this situation; I can see why you are exercised and concerned over this thing; but why doesn't the government get after the street car lines to take up these rails?" At that time, I had to tell him I had been so busy with the railroads that I couldn't find out, but I have found out since.

I have in my files in Washington one report that lists 277,000 tons of street car rails that can be made available to the government. Almost all these projects are entangled with legal, financial or political aspects. I immediately turn such matters over to the Special Projects branch. We have to deal with local chambers of commerce and other local officials and, to make matters worse, most of this rail comes up at an expense far in excess of the amount that can be recovered from the sale of the scrap. We have taken up a lot of street car rail; many large cities are taking it up; volunteer organizations are taking it up. I received a wire recently from steel workers in Houston, Tex., who volunteered their services to take up certain street car rails. We take advantage of those isolated cases, but they do little good in the general picture, and not until the recent establishment of War Materials, Inc., has there been an agency set up within the government to subsidize this work and to make it possible to recover this scrap.

Plan Financial Aid

I am not privileged to talk too much about War Materials, Inc., but I will say that it is going to have a vital effect on railroad salvage work; and it is a matter of great importance, because on one large Eastern railroad a survey revealed 15,000 tons of scrap that have not been made available to the government because of the high cost of recovery. As I understand the workings of this new department, there is \$500,000,000 at its disposal. That will make it possible to recover mountains of scrap that formerly has not been available to the government. As time goes on and I get more information than I now have, and find out how to correlate ordinary salvage practices with the new salvage practices, I will inform the chief executives and chief operating officers of the railroads.

We have a very definite and very serious responsibility. Our ships must not be late in reaching the theater of war. We don't want our boys over there raked with machine gun fire and watching the horizon for American ships that possibly do not arrive because of delinquency in the performance of our duties here as we know them to be.

The railroads have two jobs to do.

Everyone realizes the vital need of unimpeded transportation, but, in addition to that, the railroads are being depended upon to furnish a large part of the scrap needed for war production. These are the particular duties of every railroad man.

Supply Companies Save Critical Materials

(Continued from page 793)

a very promising opportunity for sizeable over-all savings and is endeavoring to realize savings in this field.

The composition used in G-E standard babbitt for rotating apparatus bearings over a period of years has been one containing 83.33 per cent tin. Now, as a result of detailed investigation and tests, it is making extensive use of a lead-base babbitt containing 82.5 per cent lead, 15 per cent antimony, 1 per cent arsenic, 0.5 per cent copper and only 1 per cent tin. As a result, the savings possible in tin are estimated to be in the order of 200,000 lb. per year at the present rate of production.

For all general purpose soldering, a composition of 40 per cent tin and 60 per cent lead has been popular throughout the company in the past, but as the result of research and tests, this has given way to compositions of much lower tin content, including one of 20 per cent tin, 1 per cent silver, and 79 per cent lead, which is being found highly adapted to many classes of work, with only minor changes in technique, temperature and operating schedules. On the whole, the substitutions that have been made and those that will be made in the near future, will account for savings of more than 50 per cent of all the tin that would be required if these alternates were not adopted.

And so it goes through the widely ramifying products and production methods of the company—in copper, in chromium, in nickel, in tungsten, in formaldehyde, in rubber, and in one hundred or more other materials needed in the war effort. Thus, the manufacturers of railway materials and equipment are contributing substantially to the war effort, with, at the same time, the fullest regard for the critical needs of the railways. What will happen after the war as regards all of the changes being made in materials is not of the essence at the moment. What is of the essence is that railway supply manufacturers are now contributing "Materials for Victory" in a whole-hearted and highly substantial way.

Bridge and Building Officers

Make All-Out Attack On War-Time Problems

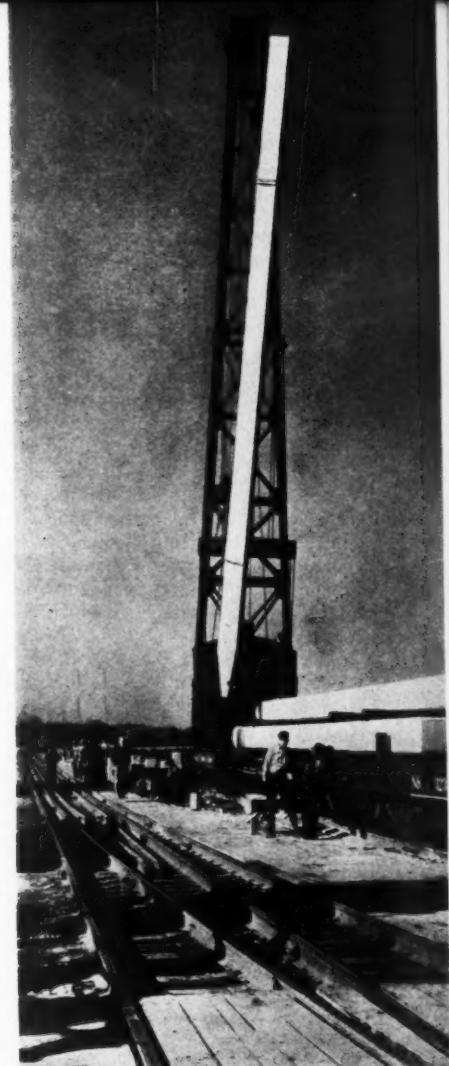
In intensive three-day meeting at Chicago on October 20-22, prominent railroad officers and representatives of the WPB, the ODT and the AAR discuss materials, labor, car and locomotive supply, blackout lighting, protective measures against sabotage and other war-time subjects. They also give consideration to eight technical reports on material conservation, improved water supplies, accident prevention, bridge repairs, piles and pile driving, floors, cleaning of masonry structures, and rail fastenings on bridges. A report of the meeting is published herewith, except for certain addresses, which will be presented in subsequent issues.

In step with the all-out effort of the railways to keep pace with the wartime transportation demands of the country, members of the American Railway Bridge and Building Association met in Chicago on October 20-22, to consider their specific problems and to throw their weight, individually and collectively, into the struggle, to the end that the bridges and other fixed structures of the railways will not become a limiting factor in the ability of the railroads to carry the tremendous load being placed upon them. From opening to closing sessions, the meeting was keyed closely to the war effort of the railways, with 11 addresses and 8 committee reports giving emphasis to the most critical problems of the moment, including materials, labor, scrap, reclamation, car and locomotive supply, safety, adequate water facilities, the protection of railway structures, and the generally increased responsibilities of bridge, building and water service officers and employees.

Among the speakers were C. E. Johnston, chairman of the Western Association of Railway Executives and associate director, Western region, Office of Defense Transportation, Chicago, who, opening the meeting, reviewed the problems facing the railways and challenged those present

to dedicate their hands, their minds and their hearts to winning the war through the adequate maintenance of their facilities; Ralph Budd, president of the Chicago, Burlington & Quincy system, who, at the annual luncheon on Wednesday, urged all-out devotion to present responsibilities and consideration of post-war conditions; Edwin M. Fitch, assistant director, Division of Transportation Personnel, Office of Defense Transportation, who spoke on the Outlook for Labor in Bridge, Building and Water Service; David P. Beach, assistant chief, Maintenance Equipment section, War Production Board, Washington, D. C., who discussed Critical Materials in Wartime for Bridge, Building and Water Service Work; and W. D. Beck, district manager, Car Service division, Association of American Railroads, who spoke on Reducing Demands for Cars and Locomotives for Handling Bridge, Building and Water Service Materials in a Period of Maximum Traffic.

Others who addressed the meeting were B. R. Kulp, chief engineer, Chicago & North Western, Chicago, who spoke on the Protection of Railway Structures in Time of War; R. P. Hart, bridge engineer, Missouri Pacific, St. Louis, Mo., who discussed the



Possibilities for Reclamation and Salvage in Bridge Work; and the three following men—J. B. Hunley, engineer of structures, New York Central, Lines West of Buffalo, Chicago; O. G. Wilbur, appraisal engineer, and until recently, field engineer, Building department, Baltimore & Ohio, Baltimore, Md.; and G. E. Martin, superintendent of water service, Illinois Central, Chicago—who joined with Mr. Beach at the afternoon session on Wednesday in a symposium on What We Can Do to Meet the Material Situation.

Still another address before the meeting was by W. G. Darley, illuminating engineer, Lamp department, General Electric Company, who, at a special session on Tuesday night, discussed the Problems of Protective and Blackout Lighting.

Technical reports were presented on the following subjects: Preventing Accidents Among Bridge and Building Employees, by a committee of which E. H. Barnhart, division engineer, Baltimore & Ohio, Garrett,

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Ind., was chairman; Cleaning of Masonry Structures, by a committee of which W. A. Huckstep, general building supervisor, Missouri Pacific, St. Louis, Mo., was chairman; Meeting the Demands for Increased Water Supplies in Fast Freight Service, by a committee of which J. P. Hanley, water service inspector, Illinois Central, Chicago, was chairman; Wearing Surfaces for Building Floors, Platforms and Roadways, by a committee of which T. H. Strate, division engineer, Chicago, Milwaukee, St. Paul & Pacific, Chicago, was chairman; Conservation of Bridge, Building and Water Service Supplies, by a committee of which F. G. Campbell, assistant chief engineer, Elgin, Joliet & Eastern, Joliet, Ill., was chairman; Rail Fastenings on Bridges, Pits and Turntables, by a committee of which J. S. Hancock, bridge engineer, Detroit, Toledo & Ironton, Dearborn, Mich., was chairman; the Repair of Steel Bridges, by a committee of which A. R. Harris, assistant engineer bridges, Chicago & North Western, Chicago, was chairman; and Piles and Pile Driving, by a committee of which W. F. Martens, general foreman, bridge, building and water service, Atchison, Topeka & Santa Fe, San Bernardino, Cal., was chairman. Summing up at the closing session on Thursday, A. E. Bechtelheimer, bridge engineer, Chicago & North Western, reviewed the many constructive ideas brought out in the various addresses, reports and discussions.

Lending their support to the meeting, the Executive committee of the American Wood-Preservers' Association, and four committees of the American Railway Engineering Association, met in Chicago concurrent with the meeting and entered into the deliberations at certain of its sessions. The A.R.E.A. committees were those on Buildings; Wood Bridges and Trestles; Wood Preservation; and Water Service, Fire Protection and Sanitation. All of the sessions of the meeting, which was held at the Hotel Sherman, were presided over by R. E. Dove, president of the association, and assistant engineer, Chicago, Milwaukee, St. Paul & Pacific, Chicago. One hundred ninety railroad men registered their attendance at the meeting, while the total attendance, including railway supply men, was 323.

G. S. Crites Elected President

In the election of officers for the ensuing year, G. S. Crites, division engineer, Baltimore & Ohio, Punxsutawney, Pa., was advanced from second vice-president to president; R. E. Caudle, assistant engineer of structures, Missouri Pacific Lines, Hous-

ton, Texas, and a director of the association, was elected first vice-president; A. M. Knowles, assistant engineer of structures, Erie, Cleveland, Ohio, was advanced from third vice-president to second vice-president; Neal D. Howard, managing editor, *Railway Engineering and Maintenance*, Chicago, was advanced from fourth vice-pres-

vance of Mr. Varker to fourth vice-president, and F. G. Campbell, assistant chief engineer, Elgin, Joliet & Eastern, Joliet, Ill.; J. S. Hancock, bridge engineer, Detroit, Toledo & Ironton, Detroit, Mich.; and L. C. Winkelhaus, architect engineer, Chicago & North Western, Chicago, each for a term of two years.

The report of the secretary showed 618 members of the association, including 46 taken in during the year. Chicago was selected as the meeting city for 1943, and the following eight subjects were selected for study by committees during the year: Salvaging Bridge, Building and Water Service Materials; Men—How to Secure and Hold; Materials—Possibilities of Relief Through Substitution; The Maintenance of Coaling and Sanding Plants to Meet Today's Exacting Requirements; The Cleaning of Pipe Lines in Water Service; Securing Maximum Utilization of Work Equipment; Revising Working Practices to Eliminate Interference with Traffic; and Carrying Over Bridges and Trestles.

All of the committee reports presented at this year's meeting, with abstracts of the discussions which followed their presentation, as well as abstracts of President Dove's address, of greetings brought by representatives of the American Railway Engineering Association and the Roadmasters' Association, and of the addresses by Messrs. Johnston and Budd, are presented in this issue. The addresses by Messrs. Fitch, Kulp, Beach, Beck, Hunley, Wilbur, Martin, Hart and Darley, will be presented in subsequent issues.

President Dove's Address

In his presidential address, President Dove reviewed the activities of the association during the year, called attention to the many problems facing the railways, and urged railway officers "to do the job that must be done, and to do it now." He said in part:

"Our meeting here today can be attributed to the fact that your officers felt that such a meeting would be of help to our national war offensive. Transportation, from the very beginning, has been an essential adjunct to successful warfare—be it offensive or defensive. The railroads are by far the most dependable and satisfactory of all forms of transportation, and it is clear that we must keep them functioning properly to achieve our objectives of winning the war."

"Today, our railroads are faced with the task of handling the largest tonnage they have ever carried, and it must be done with less manpower, equipment and materials. The year



R. E. Dove
President

Mr. Dove is an assistant engineer in the chief engineer's office of the Chicago, Milwaukee, St. Paul & Pacific at Chicago, with which road he has been engaged for 21 years in track and bridge and building maintenance in division offices at Sioux City and Ottumwa and since 1930 on the staff of the chief engineer at Chicago. Mr. Dove became a member of the association in 1934. He was elected a director in 1935 and progressed through the various offices. As president he has given the organization constructive leadership during days that have been unusually difficult.

ident to third vice-president; and J. L. Varker, supervisor of bridges and buildings, Delaware and Hudson, Carbondale, Pa., was elected fourth vice-president. In addition, Lorene Kindred, Chicago, was elected secretary, and F. E. Weise, chief clerk to the chief engineer, Chicago, Milwaukee, St. Paul & Pacific, Chicago, was re-elected treasurer. Four new directors were also elected, including L. K. Miner, supervisor of bridges and buildings, New York Central, Albany, New York, for a term of one year, to fill the vacancy created by the ad-

1942 will be a peak year in the production of heavy supplies of war, and we have been told that the goal of production in 1943 will be revised upward. On top of all this, our competitors in the transportation field will be handling less. Therefore, it is now up to us to show what we can do. If

limited supplies of labor and materials. We will not have all of the materials that we think we need. Under these conditions, the railway officer who is alert to any situation that arises, who is self-reliant, and who will rapidly employ his creative faculties in useful practices, will be the one whose facil-

the railways those men with initiative and ability who will be leaving for work elsewhere if not given greater reward and responsibility.

"Already the military men are looking at the younger men, those 18 and 19 years old—men whom we thought we could safely employ and train.



F. H. Soothill
First Vice-President



G. S. Crites
Second Vice-President



A. M. Knowles
Third Vice-President



N. D. Howard
Fourth Vice-President



A. G. Shaver
Secretary

Bridge and Building Association

Officers 1941-42

R. E. Dove, president (assistant engineer, C. M. St. P. & P., Chicago).

F. H. Soothill, first vice-president (chief estimator, I. C., Chicago).

G. S. Crites, second vice-president (division engineer, B. & O., Punxsutawney, Pa.)

A. M. Knowles, third vice-president (assistant engineer structures, Erie, Cleveland, Ohio).

N. D. Howard, fourth vice-president (managing editor *Railway Engineering and Maintenance*, Chicago).

A. G. Shaver, secretary, 310 So. Michigan Ave., Chicago.

F. E. Weise, treasurer (chief clerk, engineering department, C. M. St. P. & P., Chicago).



F. E. Weise
Treasurer

Executive Committee

H. M. Church, past-president (general supervisor, bridges and building, C. & O., Richmond, Va.).

(Term Expires October 1942)

R. E. Caudle, assistant engineer structures, M. P., Houston, Tex.

I. A. Moore, trainmaster, C. & E. I., Salem, Ill.

W. A. Sweet, general foreman, bridge and building, A. T. & S. F., Newton, Kan.

(Term Expires October 1943)

J. L. Varker, supervisor, bridge and building, D. & H., Carbondale, Pa.

L. E. Peyer, assistant architect, S. P., San Francisco, Cal.

Martin Meyer, supervisor, bridge and building, C. & W. I., Chicago.

we are to be the efficient arsenal for the United Nations and provide the fighting men with what they must have, the railroads have a job to do, and it must be done now.

"A recent public-opinion survey made for the Association of American Railroads developed that the public fully expects the railroads to handle the transportation load, even though peak is piled upon peak. It will be a sorry day for us if we do not measure up to this confidence. The public will not be sympathetic to any alibis when it is faced with the necessity for adjusting its own habits to the rationing of clothing, food, automobile use and even transportation.

"As railway officers, we are entering a period of unusual opportunity to exercise our ingenuity for maintaining our facilities in the face of

ties will be the least impaired after our battle is won.

"Also, as railway officers, we have already felt the loss of some of our valuable foremen and workers to the military services and to other more lucrative occupations. We cannot stay the arm of the military when it selects our men, but we can retain for

This will mean an increase in the average age of our employees, which, in turn, will call for closer supervision than in the past to safeguard these older men, many of whom will be called upon to work longer hours.

"As employees, we should have faith and confidence in our superior officers and those in other departments. When things are provocative and distressing, we should not condemn these men as bunglers. We should believe, for example, that our purchasing and stores officers are doing their best to secure the necessary materials for us, and that they, too, are limited as to what can be done. Also, as employees, we can help in the national scrap campaign. Yet, in our enthusiasm in this regard, we should not cast into the discard those materials that can be rehabilitated. To do

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so might create a situation that would call for new materials.

"In first aid we learn that the chances of recovery for the victim are greater if treatment is given in the first precious minutes after injury. This is likewise true in the care of our work equipment—equipment that will become more essential to us as our labor problem becomes more acute. It would be well for us to bear this in mind.

"Railroad men have always been patriotic and quick to rise in support of their country in times of stress. I have the utmost confidence that they will again meet the many problems of the present emergency, and that they will do it now."

H. R. Clarke Urges Loyalty and Adequate Maintenance

Speaking in the dual capacity of president of the American Railway Engineering Association, and as a chief maintenance officer, H. R. Clarke, chief engineer maintenance of way of the Burlington system, brought greetings from his association, stressed the importance of adequate track and structures maintenance, and urged the continued full co-operation of maintenance of way and structures employees to the end that the railroads will be able to continue their present outstanding service in the war effort of the country. Given this co-operation and their essential requirements in labor and materials, he expressed full confidence that the railroads will not fail to meet any wartime demands that will be made upon them. He said, in part as follows:

"Today we are at war. We have one task—and only one—that is to win as quickly as possible and in the most decisive way. Everything else must give place to this one objective. The railroads have a vital part to play, a tremendous load to carry in the all-out effort, and we who are responsible for maintaining the bridges and structures that carry the war traffic must see to it that we do not fail.

"I sometimes sense a feeling on the part of a few that it is unpatriotic to carry on with essential usual activities, to keep up the normal repair and maintenance programs. To me that attitude is weak and absolutely out of order. Fortunately, this applies to very few. The great majority of those in charge of all branches of railroad maintenance well know the importance of adequately maintained tracks, bridges and signals to the successful operation of the railroads, and what it would mean to the war effort if any of these vital units should fail.

"Your officers and directors had both faith and courage when they de-

cided to hold a meeting at this time. The easy way would have been to have done as so many others have done—close down for the duration. In my opinion, that would have been the wrong way.

"Not long ago Joseph Eastman said, 'Maintenance must not be allowed to fall into arrears, and no one has a heavier and graver responsibility than the men who are in charge of this work.' Certainly no one is more fully alive to what will happen if maintenance should fall too far in arrears than are the men on the firing line—those who are carrying the responsibility of which Mr. Eastman spoke. No one knows better than they the difficulties that confront them, and no group of men is more grimly determined that they shall not fail.

"Traffic today is at an all-time high. That often means larger and heavier engines as well as more and heavier car loads. We must be sure that our bridges are adequate to carry this increased load and are properly maintained for this heavier and faster traffic. Initiative, resourcefulness and ingenuity on our part are needed to do the things that must be done, but the job is ours and we know how to do it. Nowhere are the qualifications I have just mentioned needed more, and nowhere are they found more frequently than in the bridge and building forces.

"So far the railroads have done such a splendid job that the fear has been expressed by some that we might become self-satisfied and complacent. I have no fear that such an attitude will develop. That has not been our training. We believe that no matter how well a job has been done, it can be done better. If failure should come, it will not be due to lack of determination and effort on our part.

"There is one thing which gives us all deep concern. Some in authority know that for the railroads to continue their outstanding record of service, they must have reasonable amounts of vitally needed materials and be protected in their labor supply to the same extent as other essential war industries. Mr. Eastman and some of his staff know this, and in them we have influential friends, but, unfortunately, there are others in authority who express confidence that the railroads can continue to meet successfully all demands imposed upon them, no matter what further restrictions are necessary. I hope and believe that the fallacy of this reasoning can and will be presented to these men in such a way by those who do understand the situation correctly, that the tragic phrase, 'Too little, too late' will not apply to the railroads.

"We have already found the going hard and know that it will become

even more difficult. There has been a surplus of labor for the last 12 years. Today there is a shortage. Many men in supervisory capacities today have had no previous experience handling men under conditions as they are at present. New methods must be tried for recruiting labor and an intensive training program must be developed and carried out. Foremen and supervisors must be alert as never before to find men with the necessary latent ability, and to train them for the work they must do.

"The material situation is fully as critical as that of labor, and it is our responsibility to determine most accurately just what is needed and when, and then to see that advice is given through the proper channels. When it can be done, less critical materials must be substituted for those which are more in demand. We must be sure that no surplus or unneeded stocks are allowed to accumulate. Material or equipment unused in one place may be needed desperately somewhere else to prevent a crippling break down.

"We have been at war a little more than ten months with the most ruthless nations of modern times. Since December 7, 1941, there have been few days that we could forget that fact, and the pace is becoming faster: the demands greater. We are familiar with the job the railroads are being called upon to do, how vital it is, and how well it is being done. We know how difficult it has been—we also know that failure would be tragic, almost fatal. Therefore, we are determined to do our part, that we shall not fail."

Roadmasters Send Greetings

E. L. Banion, roadmaster on the Atchison, Topeka and Santa Fe, at Topeka, Kansas, and president of the Roadmasters' Association, brought greetings from that association, urged those present to continue their fight on the home front in support of those at the fighting front, and then offered a number of suggestions in the interest of meeting the problems that confront maintenance of way and structures men in the days ahead. He said, in part as follows:

"While bridge and building men have seen difficult days in the past, there may be even more difficult days ahead. You must go on, and by your efforts help keep the railroads in a condition adequate to transport the requirements of our war effort.

"Today we face a serious shortage in railway labor. In some sections of the country the supply has been exhausted for many months. While I have no simple solution for this problem, we can do much to help ourselves

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by adopting into our ranks men who were formerly considered unsuited for such work. We must, whenever possible, adapt machines to perform the tasks of skilled workmen. We must work the machines longer hours;—two or more shifts each day, if necessary, to secure their maximum output. We must secure machines with the widest range of usefulness to insure their continuous operation throughout the year. We must secure full co-operation between the several maintenance crafts to avoid losing time in moving machines from one job to the other, or in waiting for machines to be released. The programming of work to provide a uniform force throughout the year will do much to prevent losses from our present forces to other industries.

"It has been said that there must not be 'too little, too late.' On the other hand, there must not be 'too much, too soon.' There must be no hoarding

of repair parts, or of emergency or working stocks. Excess repair parts and surplus stocks should be turned back into the central supply. Working stocks should be held to a minimum. Tool and material cars should be inspected frequently to avoid over stocking. Materials that cannot be repaired and returned to use should be scrapped promptly.

"In view of the serious shortage of railroad equipment of all kinds, particularly of rolling-stock, we must release company loads promptly. Self-propelled locomotive cranes, shovels, pile-drivers, derricks and similar equipment should be used whenever possible to preclude the use of locomotives. The present scarcity of critical materials will force the use of substitutes for many of our most commonplace materials of the past. I am sure that you men will find ways and means of providing these substitutes as the occasion demands."

line over which must move, in ever-growing volume, the raw materials from mine and forest and field to factory; the main line too, over which the finished products of tanks and guns and shells must flow unceasingly from our factories to the fighting fronts throughout the world. We are the lines behind the lines—the service of supply of an embattled nation.

"Today, the War Department is by far the largest user in the country of railroad transportation service, both freight and passenger. In the nine-month period beginning December 7, 1941, troop movements by rail totaled approximately 6,500,000, as compared with 1,900,000 during the first nine months of the last war. Then, too, these troops are moving with greater speed and comfort than was the case 25 years ago. In 1917, the average speed of special troop trains was less than 25 m.p.h., compared with an average speed today of 30 m.p.h.

"Next to the army, the navy is the largest user of rail facilities in time of war. Thousands of freight cars are moving daily in the direct service of our sea forces. The Naval Bureau of Supplies and Accounts alone routes an average of approximately 50,000 freight cars a month, and this does not include shipments under private bills of lading going to plants engaged in fulfilling navy contracts.

"Not only must our soldiers and sailors be armed and equipped—they must be fed, as well. The American railroads are moving record quantities of food for our army and our navy. It takes about twice as much food to feed a man in uniform as it does a civilian. To feed our army and navy requires about 3,500 carloads of food-stuffs each week. In addition, we are shipping enormous quantities of food to our allies, and practically all of this is moving to ports by rail. This export movement amounts to between 700 and 1,000 cars a day. A large number of these cars must travel long distances, often thousands of miles.

"These military needs are the primary responsibility of the railways today. Meeting them in full is the first problem we have before us. So far, that problem has been met successfully. But we have other responsibilities, as well, with their attendant problems. We still have our normal responsibilities to the people of the United States. They must be fed and clothed and warmed—their essential needs for transportation service must be filled. Meeting that responsibility in full is the second problem we have before us. So far, that problem, too, has been met successfully. We must continue to meet it successfully.

"Thus, we find ourselves today called upon to furnish the greatest

C. E. Johnston Appraises the Tasks Ahead, in Opening Address



C. E. Johnston

to achieving that objective. Reviewing the problems that face railway men, Mr. Johnston cited particularly the unprecedented demand of the military forces and war production for transportation, on top of that for normal civilian requirements, and the problems of shortages of needed materials and manpower. These, he indicated, will put the railways to a severe test, but he expressed full confidence in his listeners to do their part, and in the railways, given their essential minimum requirements, to meet all demands. He said, in part as follows:

"To win this war—that is our one great problem. And to the satisfactory solution of that problem we must dedicate our hands, our minds, our hearts and our souls. Until we are able to solve that problem, all others are less disturbing.

"This is war, total war, and in total war our essential industries stand shoulder to shoulder with our army and our navy in their spearhead of attack. We can rely upon the courage and the strength of our fighting men, but they must be supplied constantly with more weapons and with better weapons than those used against them by our enemies. It is the production line that makes the front line possible.

"In our great national production line, the railways, as usual, are the main line of transportation—the main

Speaking on The Problems That Concern Us, in opening the meeting, C. E. Johnston, chairman, Western Association of Railway Executives, and associate director, Western region, Office of Defense Transportation, Chicago, sounded the keynote for the entire meeting, declaring at the outset that the greatest problem of the nation today is to win the war, and that every act of the railways and of railway men should be dedicated

volume of service, both freight and passenger, in the entire history of the railroad industry. And the trend of traffic is upward. After 1942, there will be still more traffic to move. Just how much, no one can say with certainty, although tentative estimates have been made of a 15 per cent increase in both freight and passenger traffic next year.

"Only by surpassing all previous records of operating efficiency in the use of equipment has it been possible for the railroads to meet the unprecedented demands that have been made upon them. But there is a limit to such accomplishments. The railways must have additional equipment to match, in some degree, the increase in the demand for transportation service. This is another of the problems which now confront us—and a problem that also must be met successfully.

"Still other major problems confronting us are the problems of shortage—in manpower and materials. Essential though the railroad industry is, we can anticipate, nevertheless, that as the war goes on, more and more

railway men, including those in your own department, will be called to active service with our armed forces. We can anticipate, likewise, that the supply of men who formerly would be available for railroad employment also will be depleted through this same cause and through the demand, as well, of other war industries. The material shortage is not a matter of mere anticipation in all regards. In some respects it is already an actuality. You may, and probably will, be called upon to do more and more with less and less. You will have to do the best you can with what you have.

"We are convinced that our task of winning the war will be the greatest and the most difficult task we have ever known. It will be even greater and more difficult tomorrow than it is today. Your part in the struggle—the safe and adequate maintenance of the railroad track structure, bridges and other essential facilities, is second to none in importance. You have had a part in making the American railroads the best in world. I am sure that you will maintain this record."

terials where possible, the avoidance of waste and of ordering more material than is absolutely needed; also, that orders for such materials as are essential are placed in time so that they can be provided in the ordinary way. The greatest attention needs to be given to these matters. The other problem has to do with the personnel of our working forces, because of the coming shortage of manpower. Indeed, this latter problem may be the more critical of the two, although both of them are extremely critical.

"We are now getting many new and inexperienced workers. The kind of railroad men these men will be depends to a large extent upon the training they receive from their fellow employees and their foremen. These men will have a good or a bad opinion of their companies, and will be valuable or otherwise, depending largely on how they are trained. At every opportunity, the responsibility for training these men, which goes along with the privilege I first mentioned, should be brought home to all of your essential workers.

"Then the question of safety is involved, so that our new men will use material properly and safely. Present safety figures are not particularly gratifying to us, although the reason, no doubt, is the larger volume of traffic that is being handled, the pressure under which men are working, and the large number of new employees.

"In 1941, there was an increase of 25 per cent in casualties to employees on duty—a large increase. Thus far in 1942, accident reports indicate a further increase. That increase, however, is as compared with years when our safety record was extremely good. Compared with 1927, the accident record of 1940 was very favorable, the decrease being 56.9 per cent; less than half as many injuries in 1940 as there were in 1927. But the accident records of the railroads present a challenge to us, a challenge which is always present and goes hand in hand with this thought of carefully training and helping new employees.

"A word should be said about the prospects of the railways after the war and what, if anything, can be done at this time about them. Consideration of the post-war status of industry is vital for several reasons, but chiefly because of the dislocations which are now being created by shifting from a peace-time to a war-time basis of production, which, in the shift back, unless something is worked out in advance, might well result in near chaos. The danger of such an eventuality might bring about a situation where, without plans for employment to again take up productive activities, it may be necessary for the govern-

Ralph Budd Sees Need For Consideration of Post-War Problems



Ralph Budd

too early to give consideration to the post-war place of the railways, and industry in general, to avoid what "might well result in near chaos." He said, in part as follows:

"During the present war, the railroads are a favored group. We are favored because we are engaged in a business which is very definitely a part of the war activities, and never should be thought of as apart from them. But, as so often happens, the privilege and favor we enjoy carry with them a very great responsibility to make sure that everything that we do contributes the utmost to the war effort.

"We should keep always before us this motto—'Do today the most that can be done to contribute to the war effort.' And I think that this test is one which should be applied not only to all railroad men, but to all members of the government staffs dealing with the railroads as well.

"There are two general problems that confront railway officers such as are here today. I am sure that you are considering both of them very earnestly. One is the greatest care in the use of materials which have become scarce, the use of substitute ma-

Addressing an audience of nearly 300 at the annual luncheon of the association on Wednesday, Ralph Budd, president of the Chicago, Burlington & Quincy system, urged railway men to their greatest effort in the prosecution of the war, but cautioned, with emphasis, that it is not

ment to bridge the gap with a great deal of federal work.

"I am one of those who believes that the expenditure of funds by government can never take the place in a free society of the very much larger expenditures which free enterprise can produce. For this reason, I think it is well for those who believe this, to see what can be planned in advance.

"There are schools of thought along the two lines—one, that the job will be too great for private enterprise to cope with and, therefore, that the government must take over; and the other, to which I belong, that reliance must be in private enterprise, with a minimum of government. In discussions of these beliefs, I see too little consideration of the contention that, as a prerequisite of successful progress after the war, private enterprise, and particularly those that are services, must be subject to regulation. I see too, too little discussion of the importance of having a well-defined

policy of government to the end that the restrictions and inhibitions which we are willingly accepting now in order to win the war, shall be understood as accepted only temporarily, and will be removed as promptly as possible after our victory. Assurance in this latter regard, together with a post-war planning which will encourage the entrance of free enterprise again into all of the activities which have produced for us our great industries, would go a long way toward giving the reassurance we must have.

"The railroads will not lag in initiative and ingenuity to take care of themselves if they are given the proper atmosphere of regulation. For the time being, we have had to give up a great many technological advances and advantages because certain materials are not obtainable, but immediately when they become available again, we will start where we left off, or perhaps a little further along, and I venture to say that there will be no

lack of projects, and no lack of employment and productivity, if we are given the proper support from those under whom we must work. Our immediate problem is, of course, to get those materials and the manpower which are absolutely necessary. This problem must be recognized by those who are going to have the say as to how available materials and manpower are to be allocated.

"We are fortunate at this juncture in having Joseph B. Eastman as the Director of the Office of Defense Transportation, because he knows very well, probably better than anyone else, about how much the railroads are capable of doing, and when it is absolutely necessary, in the interest of prosecuting the war, to give them more material. We must have the necessary materials—we must have the necessary men. With them, I have the fullest confidence in the men who are represented here, to bring about entirely satisfactory results."

Piles and Pile Driving

Report of Committee

ECONOMY requires that the proper length of piles be determined in advance. A careful exploration should be made of the soil in the absence of definite information regarding piles previously driven at the same location and if the job is of sufficient magnitude. Driving test piles is desirable, since it furnishes, in addition to the proper length of piles, information as to the time required to obtain the necessary penetration and hence the approximate time for driving piles later. If it is not expedient to drive test piles, exploration should be made by sounding rod, earth auger, wash borings, core drilling, boring machine, or test pits. Tests should be made at proper intervals for the entire length of long pile trestle bridges, at the location of all piers and abutments, or at several places properly distributed for a building foundation. Failure to make adequate tests to determine the proper length of piles may result in waste of timber in excessive cut-offs, or closing down the work because of the piles being too short and having to arrange for longer material. In the case of metal or concrete piles, the excessive cost of material, labor and time could be very costly, as well as seriously delaying the work.

The pile driver still is of the first importance in the construction of pile trestles and foundations requiring bearing piles. Present-day train schedules and density of traffic require a



W. F. Martens
Chairman

track machine of modern type, that, with idler car and tender car attached, can move under their own power, at a speed of not less than 20 m.p.h. The driver should have at least two speeds, the lower for spotting the machine during pile driving operations, and starting, and the higher speed for making moves requiring faster running.

The trend in pile driver design is toward air controls in lieu of the conventional levers for manipulation of the hoisting drums and swinging and

traveling mechanisms. Dual purpose machines are not desirable, except when there is insufficient work to justify a single-purpose rig. While there still exists a difference of opinion with regard to the relative merits of the single end and the full revolving machine, the trend is definitely toward the latter.

Track pile drivers should be capable of handling a load of 20,000 lb. in the leads at right angles to the track without employing outriggers. The leads should be not less than 50 ft. in length and equipped with a power-operated battering device. A winch head is a necessary adjunct.

Gasoline engine or steam turbine-operated generators to supply current for electric lights and an independent compressor for furnishing air to operate pneumatic tools should be standard equipment. Off-track pile drivers have not been used to any extent for driving piles in existing railway trestles. For the construction of bridges on new lines, skid, roller and ground hog pile drivers have been in use since railroads were first built. In recent years, the crawler-type crane has come into use quite extensively for driving all sizes of wooden and steel piles and the smaller sizes of concrete piles for bridge, building and dam foundations. Hanging leads are attached to the boom point. Sometimes, to stabilize the leads to control more accurately the direction of the piles as they are

driven into the ground, two heavy struts are attached to the bottom of the leads and connected to the revolving frame of the crane. These struts are crossed, in some instances, to provide additional rigidity.

Pile Hammers

The drop hammer has almost lapsed into disuse, being used only on small jobs where the more elaborate and expensive equipment required for steam hammer operation is not justified. Drop hammers are usually operated by means of a wire or manila rope attached to a round pin in the top of the hammer and are raised by a hoisting drum powered with a steam or internal combustion engine with a friction clutch.

When the hammer is used in connection with a driving cap, as when striking the head of a metal pile directly, its base should be made flat, but if it is to hit the heads of wood piles, the base should be made slightly convex. This will help to keep the pile in line, reduce the strain on the toggles and minimize the effort of the front end crew.

Drop hammers used to drive wood piles for the average run of railway structures should weigh from 3,000 to 4,000 lb. It is better to have a hammer with excess weight for the work contemplated than to use one that is too light, as the fall of the hammer can be regulated as conditions demand.

The drop hammer is of low first cost and does not require a steam hose. It is claimed that it will drive a pile to greater penetration under certain conditions than a steam hammer, while it is easier and less costly to transport.

The steam hammer has been made in this country for about 70 years. Its popularity has increased, particularly during the last 20 years, until now most pile driving is done with this type of pile hammer. The steam hammer permits more piles to be driven in a specified time. Piles may be driven as much as 6 to 11 ft. (depending on the size and make of the hammer), below the bottom of stationary leads, and usually 2 to 3 ft. below the base of rail, thus effecting that much saving in cut off. It causes less damage to the pile head, such as splitting, excessive brooming, etc., and eliminates the splattering of creosote caused by the hammer striking the pile head. The steam hammer enables piles of softer or inferior wood to be used. The head of the pile is held more securely in position and piles may be driven with greater accuracy, as well as avoiding the labor of toggling and spudding. The steam hammer may be used where head room is insufficient for

drop hammer operation. The hammer line will last much longer, and there is considerably less wear and tear to the pile driver than with a drop hammer, with resulting reduction in maintenance cost.

There have been claims and counter-claims as to the comparative merits of the single-acting and double-acting steam hammer. Those who have had experience with a drop hammer will agree that a light drop hammer with a high fall, and consequent high velocity of impact, is not nearly so effective as a heavy drop hammer with a low fall and consequent low velocity of impact.

A high velocity of impact allows the hammer to broom the head of the pile instead of driving it into the ground. Irrespective of the number of blows per minute that can be delivered, the velocity at the time of hitting the pile can be so high and the ram so light that the energy of the blow will be entirely absorbed within the pile, and not drive the pile.

What Weight of Ram?

In comparing steam pile hammers of equal total weight, it must be conceded that the one having the heavier ram will drive the more difficult pile under all conditions. There is, however, a limit to the velocity of the ram at the time of impact, which cannot be exceeded and still retain its efficiency. The steam on top of the ram of a double-acting hammer does not increase the weight of the ram. The steam pressure merely increases the velocity of the ram and allows a greater number of blows to be delivered in a given time, but each blow must have enough surplus energy to actually drive the pile. A light ram, like a light drop hammer, with high velocity of impact, will damage the pile head.

In 1927 a railway using a single-acting steam hammer drove some test piles to determine the length of piles required in redriving a pile trestle in Arizona. In subsequent pile driving at this location a double-acting steam hammer, employing a light ram, was employed. The piles ordered for the work proved to be too long, even though driving was continued until 65 per cent of the piles were set on fire from heat generated by the hammer. It required from 35 to 50 min. to drive a pile to refusal. The five piles having the largest tip diameter in the lot of 180 piles in the job, were held out and, subsequently, driven in four bents and between other piles with a single-acting steam hammer of comparable size and using a heavy ram. Even under these unfavorable conditions it only required from 20 to 35

min. to drive a pile to a penetration obtained with test piles. Only one of the five piles refused, and there was no serious brooming of the pile heads.

Lubrication

In selecting a steam pile hammer, serious consideration must be given to the lubrication system. Some steam hammers not only require refilling of the lubricators in the hammers at frequent intervals, but the job is tedious and hazardous. The oil in the lower receptacle runs out when the driver leads are laid down, which requires refill before pile driving can be resumed. Failure to keep the valve-actuating mechanism, which is enclosed and not visible, well supplied with oil will result in serious damage to these parts. The valve-actuating mechanism is rather intricate and delicate. The various features enumerated materially slow up the work and are a distinct handicap, especially where train schedules are not favorable. In addition, these hammers consume excessive steam, which, in itself, is quite a factor.

There are steam pile hammers that require no lubrication for the valve and its actuating mechanism, other than that received from the sight feed lubricator in the steam line, except that a little oil is applied to slide bar wedges, which are easily accessible.

Wood Piles

While extravagant claims have been made by the suppliers of numerous types of bearing piles, the fact is that each is most effective under conditions favoring its use. Wood, the longest and most widely used material for piles, still is the most convenient and economical material for friction piles in well timbered regions. The main objections have been that it is short lived, attacked by insects, and is easily destroyed by fire. The species most commonly used are the Southern Pines, Douglas Fir, Lodge Pole Pine, Norway Pine, Ponderosa Pine, Oak, Cedar, Spruce, Tamarack, Western Larch, Cypress, Basswood, Elm, Chestnut, Hemlock and Gum.

When durability need not be considered, as for temporary construction, or for foundations where piles will always be submerged in water (except in salt water infested with teredos or other marine borers) or buried in damp soil to such a depth as to exclude air, any untreated wood pile that will stand driving may be utilized safely.

The majority of the railroads that use wood piles for permanent pile

trestles or foundations where cut-offs are above ground water level use piles creosoted by the full-cell process, the treatment varying from straight creosote oil to a 50-50 creosote-petroleum mixture for Southern yellow pine and to a mixture of 45 per cent creosote and 55 per cent petroleum for Douglas Fir, all to refusal.

Green southern yellow pine is preferred by some roads in territories where this wood is used in salt waters; the wood is steamed in the treating cylinders at 20 to 30 lb. pressure for 20 or more hours to remove the sap and pitch; then approximately 24 lb. of creosote per cu. ft. is forced into the timber. The steaming weakens the wood, but this loss in strength is not enough to be prohibitive.

Douglas Fir will not stand steaming and may be treated for marine use either green by the Boulton process or seasoned in the usual way and using the full cell process, preceded by a heating period or bath in the preservative.

There is a wide difference in the average service life of untreated piles of various species of wood that are exposed to the elements in different localities. A certain species may be very durable in the locality where it grows, whereas, if used in other regions, it may decay completely in a few years. Port Orford Cedar piles have been in service for almost 30 years in localities on the Pacific coast where the soil is always moist without appreciable loss from decay, while if used in desert regions of Southern California and Southern Arizona, where the ground is dry, piles of this species usually fail from decay in six to ten years. The Great Northern reports 12 to 15 years service life from untreated Red Cedar piles on the west coast and from 20 to 30 years on other parts of the system.

The average service life of treated piles depends upon such variables as species of wood, locality in which used, climatic conditions, kind of preservative, treatment process, penetration and retention obtained, the piercing of treated surfaces with sharp-pointed tools in handling, improper treatment, and protection of cut-offs. Service records are not, as yet, sufficiently extensive to indicate what the ultimate life might be for the different species under various conditions of service. Piles used in sea water may have a service life as low as 10 to 15 years in the Gulf, Southern Atlantic and Pacific Coast regions, and twice this life in northern waters.

Land piling usually has a much higher service life than marine piling, and when not mutilated with sharp-pointed tools and properly protected at cut off, will probably have an aver-

Railway Engineering and Maintenance

age life of 30 years or more. Many creosoted piles in railroad trestle bridges are in sound condition after 35 years' service.

Cost of Piles

The cost of piles, both untreated and treated, varies considerably and depends upon such factors as species of wood, availability, distance trans-



A Full-Revolving Railway Track Pile Driver With 80-Ft. Leads

ported, off-line haul, kind of treatment, amount of retention, etc. Likewise, the cost of driving varies for different localities and roads, depending on the length of the piles, kind of structure, type of soil, density of traffic, distance from job to siding, type of pile driver (including whether handled under its own power or with work trains), experience of the gang and type of hammer used.

Data obtained from railroads and dealers reflect pile costs ranging from \$0.15 to \$0.40 per lineal foot for untreated piles and from \$0.43 to \$0.66 a lineal foot for treated material. The cost of driving runs from \$0.14 to \$1.25 per lineal foot.

Steel H-Section Piles

Although the use of metal piles in one form or another goes back 65 years, the wide-flange steel H-piling came into use in 1908 and is now used extensively in foundations of buildings, industrial plants, bridge piers,

abutments and, to some extent, in bents in railroad trestles. In normal times, H-sections in 8-, 10-, 12- and 14-in. sizes, and in different weights, are readily available up to 100 ft. long.

Several types of attachments are used to increase the bearing capacity of H-section piles, the simplest of which consists of steel plates with suitable stiffeners welded between the pile flanges. Short H-sections as lagging may be attached to the outside of the pile flanges, either at the bottom, or at a suitable distance above the lower end of the piles. In other cases, steel plates are welded on each side of the web at the bottom end of the piles to increase the bearing area. Steel H-piling can be used to good advantage where extreme penetration is required to drive piles in hard material such as shale or on rock.

The bottom end of the pile should not be pointed, as the square end provides a larger bearing area and does not retard driving. In fact, it prevents shifting or creeping of the pile when obstructions are encountered. Steel H-piles are able to penetrate ground containing boulders of reasonable size, submerged timber and other obstructions with little if any damage, and without throwing the pile out of alignment seriously or otherwise impairing its usefulness as a bearing member.

When exposed to the elements, and more particularly in coastal regions, steel H-piling is subject to corrosion. However, investigations conducted in various parts of this country and in Europe indicate that the impairment actually resulting from this cause has been overestimated. Corrosion usually is greatest near the ground line and is practically negligible a short distance below the surface. Many users encase H-piles in concrete a few feet above and below the ground level to keep out corrosion.

Steel H-piles have great ability to withstand long-continued hard driving. If the job requires H-piles longer than can be driven in a single length, they can be extended by splicing on an additional section. If piles are restrained laterally for their full length in firm soil and driving is moderate, a splice may consist only of a full perimeter butt weld or of web and flange plates welded or bolted on in the field. It is essential that the ends of the splice bolts do not protrude more than $\frac{1}{4}$ in. beyond the outer nut face to prevent undue strain and shearing of the bolts if they should encounter obstructions.

Splices on unsupported sections of piles should be designed to develop the full sectional strength of the piles. Where bolted splices are used, the ends of the sections should be ma-

chined perpendicular with the pile axis and be in full contact. Splices tend to force the ground away from the section above the splice as the projection passes through the soil. In soils that do not come back, this tends to reduce bearing values slightly, due to the reduction in skin friction area. Owing to the large difference in the ratio of the perimeter to the section, the skin frictional area of H-piling is much greater than for other types of piles.

Steel H-piles should not be jetted as the action of the water prevents the formation between the flanges of the compacted earth cores which are of great value in developing the load-carrying capacity of the pile.

The cost of H-piling varies widely, depending on the location, nature of the job, conditions of driving, weight and length of piles and the number to be driven, but in general it will run from \$1.25 per foot for 8-in. 31-lb. piles to \$4 for 14-in. 117-lb. piles.

Concrete Piles

Precast: The precast reinforced concrete pile was introduced in Europe about 1897 and some seven years later it was first used in America. It is now used extensively for various purposes by many North American railroads. It possesses the advantage of not being subject to decay or corrosion and is free from attack by marine borers, but disintegration of the concrete by the chemical action of sea water, as well as mechanical action in territory having rugged climatic conditions, can be expected and must be met. If the piles are properly designed, their manufacture rigidly controlled, and they are subjected to close and careful inspection, this problem can be minimized. While piles over 100 ft. in length have been used, the length generally ranges from 20 to 60 ft. for those manufactured by railroads. Most commercial firms limit the lengths carried in stock to 20 to 40 ft. Concrete piles are usually octagonal or square and vary from 16 to 24 in. for square piles and from 14 to 24 in. across the faces for octagonal piles; they are made with or without taper; the taper, when used, ranges from a few feet from the tip to the full length of the pile. When acting as a column, a pile without taper should be used; on the other hand it may be desirable that a friction pile have some taper. In general, a large pile cannot be driven so rapidly as a smaller one, but the number required may be sufficiently less to effect a saving in total cost.

The Missouri Pacific, long one of the most extensive users of concrete piles for concrete trestle structures,

averaging over 5,000 lin. ft. of bridges a year for a nine-year period, has found that 24-in. octagonal piles are more economical than the 16-in. octagonal pile, formerly used. Three of the larger piles in a bent are entirely adequate, where six of the smaller piles were required before; one pile is driven between the old timber trestle chords and one pile on the outside of each chord; this eliminates the necessity for shifting the old timber chord for pile driving, with consequent saving in maintenance cost during the construction period. It should be added that this also permits higher train speeds while the piles are being driven.

Other railroads have utilized this type of pile for trestle bridges and concrete piers. The Chesapeake and Ohio constructed a double-track pile pier a few years ago in which 36 concrete piles, each 18 in. square and 70 to 75 ft. long, were used. The piles were driven in four rows of nine piles each. In addition to the concrete caps for the bridge seat, three horizontal diaphragms, equally spaced, are used to stiffen the piles in all directions. This type of construction does not require a cofferdam. Some roads purchase piles from commercial plants while others fabricate their own.

It is essential that an unyielding foundation be provided on which to manufacture piles, to preclude any possibility of the concrete being subjected to stresses while it is setting. The use of wood and metal for forms seems about equally divided. For square and octagonal piles, reinforcement, as a rule, consists of eight longitudinal steel bars, varying from $\frac{1}{2}$ in. to $1\frac{1}{4}$ in.; both round and square bars are used spirally, tied together with heavy wire or hoops of $\frac{1}{4}$ in. steel.

Corrugated concrete piles are usually reinforced with six longitudinal bars $\frac{5}{8}$ in. and larger, with spiral wrapping of No. 9 wire.

Precast concrete piles generally are cast horizontally and are cured by a cold water spray or by steaming under cover. Piles of long lengths should be provided with multiple pick-up points to prevent setting up excessive stresses, while those of moderate length may be picked up at one end or near the middle.

The cost of precast concrete piles varies according to their size and length, the lowest being \$1.18 and the highest \$3.95, or an average of \$2.15 per lineal foot. The cost of driving varies from \$0.75 to \$3.39, or an average of \$1.78 per lineal foot.

Cast-In-Place, Cased: The cast-in-place, cased concrete pile is an American product and was first used in Chicago soon after the turn of the century. There are a number of different types, both tapered and with-

out taper. The tapered shells have a metal driving point and are used principally as friction piles, while the tubular shells are used for both friction piles and those acting as columns.

The tapered fluted type of pile shell is formed by the cold rolling process. The fluted design increases the skin frictional area and gives the pile enough stiffness and rigidity to permit driving without a core or mandrel, which, due to the reduced inertia, increases driving speeds and lighter driving equipment may be employed.

The shells are made in lengths ranging from 10 ft. to 115 ft. While 8 in. seems to be the accepted standard tip diameter, points ranging from 6 in. to 16 in. can be furnished. The butt diameter varies from 9.4 in. to 18.1 in. A driving collar is welded to the butt. Although the piles are usually made of 11-gage steel plate, they are also made in 9, 7, 3, and 0 gage; this provides a variety of shells that will generally meet most soil conditions. Standard tapers are one inch in four feet to one inch in seven feet; other tapers can be furnished for special conditions.

In limited head room, a tapered section of suitable length may be driven to ground level, after which an extension can be welded on the pile and the driving resumed. Furthermore, this method or procedure permits the placing of a pile of any length and the cutting off of that pile without the loss of the pile section cut off. The shorter lengths may be nested for shipment by rail. They can be rolled off cars without damage.

While this pile is mostly used for foundations for piers and buildings, it has been utilized also for bents of railroad bridges. The metal shell has a certain vertical reinforcement value, which in many cases eliminates all reinforcing steel, except dowels at the top of the pile. When necessary, the pile can be readily cut off at the proper elevation with an acetylene torch. Fluted piles cost from \$1.10 to \$1.96 per lineal foot, depending on the gage of metal, f.o.b. fabricators plant.

Another type of tapered pile, which has been in use about 40 years, is made of a thin metal shell. Two types are known as the standard tapered and step tapered piles. The standard pile has a uniform continuous taper; the shell is made of steel of a thickness suitable for the length and diameter of the pile and ground conditions. The shell is spirally reinforced on the inside for its full length with hard wire of suitable size, generally $\frac{1}{4}$ in. to $\frac{3}{8}$ in. in diameter. It is made in 8-ft. sections up to 40 ft., with a tip of 8 in. and a butt diameter ranging from 16 in. to 23.2 in.

Step-tapered pile shells are made

in 8-ft. cylindrical sections, of spirally corrugated metal, usually of 20 to 14 gage thickness; heavier or lighter metals are sometimes used, depending on the characteristics of the soil to be penetrated. The steps are formed by increasing the diameter of each section, usually one inch. Each shell section is provided with a double rim plow ring at the bottom end, to the lower rim of which is welded a short spirally-corrugated inner sleeve to allow the sections to be screw-connected. The tip diameter varies from 8 to 11½ in. and the top diameter from 12½ in. for 16 ft. piles, to 17¼ in. for piles 88 ft. long. Lengths up to 115 ft. have been used. The shells of both standard and step-tapered piles are relatively light; they may be nested for shipment and can be rolled off railway cars. A tapered collapsible mandrel is used for driving the standard tapered shells while a step tapered core is employed for the other pile. Owing to the heavy weight of the cores, a pile driver of rugged construction is required.

While the average cost installed, including the concrete, is about \$2.00 per lineal foot, it may run considerably less on the larger jobs. On the other hand, the cost may be substantially higher for a small job and where other factors are less favorable.

Tubular Cased Piles

Tubular or cylindrical cased piles include a number of different types, such as heavy steel pipe, continuous corrugated metal shell, composite, projectile, button with light steel casing, pedestal, and compressed concrete base section. These types of piles have not been used largely for railway bridge foundations, but have been employed quite extensively for building foundations.

Steel pipe casings are driven with open ends or conical metal points. The pipe is available in lengths of approximately twenty feet. If more than one section is required, the sections are connected with cast steel sleeves of appropriate length, with an external collar. The collar seats as well as the pipe ends are machined to insure a true alignment of the pile and a uniform contact of the metal. Common diameters of pipe or piles range from 10 to 18 in., the wall thickness is usually from $\frac{1}{4}$ to $\frac{1}{2}$ in. In the case of open end piles, the soil is removed by water jets, blowing with compressed air jets or by sand pumping. Steel pipe piles are driven without the use of a mandrel or core. Either type of pipe pile may be made up from short sections, thus requiring little headroom; sections as short as two feet are sometimes used.

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Continuous Corrugated Pile: A continuous corrugated pile is formed by fitting a core having a solid steel point into a heavy steel pipe closed at the bottom; both are driven together into the soil to the required depth; then the core is removed and a corrugated thin metal shell is placed in the steel pipe. The corrugated shell is filled with concrete; the core is then lowered into the steel casing until it rests on the corrugated shell and is secured in that position to prevent the shell from rising with the steel



When Preboring Is Required, "The Work Can Best Be Done With a Power-Driven Earth Augur"

pipe, which is then pulled out of the ground.

Button-Bottom Type: In the button-bottom type, a precast concrete point is placed at the location where the pile is to be driven and a heavy steel tube with a reinforced steel base is placed on the point; after which the procedure is similar to that described for the continuous corrugated pile.

Pedestaled Pile: For the pedestaled pile, the apparatus is identical with that used for forming the continuous corrugated pile, except that after the core is withdrawn, a charge of concrete is deposited in the bottom of the pipe; the core is then replaced and the pipe is pulled up a few feet. The core and the pipe together are driven through the concrete, the core is again withdrawn and a corrugated shell placed in the pipe, after which the operation is the same as previously described for continuous corrugated pile.

Compressed Concrete Base Sections: Compressed concrete base sections are formed by driving together a heavy pipe and core as previously outlined for continuous corrugated cased piles. A quantity of concrete is dropped in the casing and the core replaced; the casing is then raised up

over the core the desired height; as the concrete is under pressure, it forms a pile shaft at least equal to the outside diameter of the driving casing. From that point the operation is similar to that of the pedestaled pile. The compressed concrete base tends to develop the full value of the bearing strata.

Composite Pile: The composite pile consists of a concrete pile superimposed upon a wood pile. The load is carried by the timber section; the top of which must be below permanent ground water level. The concrete section serves as a column. Two methods of placement are most commonly used. One is to proceed as with the continuous corrugated pile; the core is then removed; a wood pile with a properly formed wire wound tenon is inserted in the casing and, by using the core as a follower, the wood pile is driven through the casing until a satisfactory bearing value is developed. The core is then withdrawn and a corrugated steel shell having a reinforcing cage, consisting of vertical bars with hooks, is placed in the casing. The other method is to drive the wood pile to ground level; the corrugated metal shell is then placed over the timber tenon and, with the core in place, the assembly is driven to final penetration; after the core is removed the shell may be filled with concrete.

Projectile Type: The method of forming a projectile pile is similar to that first described for the composite pile, except that a heavy steel pipe with a metal point is substituted for the wood pile. The joint between the upper and lower sections of composite or projectile piles must be so made as to exclude water and mud from the splice at all times, without resorting to pumping or other de-watering devices.

The cost of steel pipe piles ranges from \$1.16 for 10-in. diameter and $\frac{1}{4}$ -in. wall, to \$1.97 for a 12-in. pipe having a wall thickness of $\frac{3}{8}$ in. Spiral welded pipe of 12-in. diameter and No. 7 gage costs from \$0.95 to \$1.20 per foot.

Uncased, Cast-In-Place: Uncased, cast-in-place piles do not have a permanent metal casing; the concrete is in direct and intimate contact with the surrounding earth. Generally the cross section is the same as for cylindrical-cased types. Their use is limited to certain types of soil. The piles are formed in a manner similar to that employed for cylindrical cased types, except that the concrete is compressed by means of the core and pile hammer resting on the concrete while the casing is being gradually withdrawn. This method of handling precludes concrete arching in the casing.

The cost of uncased concrete piles

varies from \$1.20 to \$2.00 per lineal foot for a 14-in. diameter, uniform shaft pile, and correspondingly more for larger sizes; the cost of the compressed pile with mushroom base is \$4 to \$6 higher for the base section.

Water Jet

The water jet is one of the oldest, and under certain conditions, still the most effective of all pile driving methods yet devised. While it may be used in any soil that can be moved with water and will come back around the pile when jetting operations ceases, best results are obtained in fine sand.

Almost any type of pump that develops sufficient pressure and that will deliver an adequate supply of water will suffice. Although the piston-pattern pump was universally used for this purpose until a few years ago, the trend now is toward the multiple-stage centrifugal pump powered by a gasoline engine. This type of pump is self-contained, and since it weighs only 1,500 to 4,200 lb., it is easily installed. Standard sizes, ranging from one to four stages with capacities up to 300 gal. per min., and developing water pressures of 75 to 300 lb. per sq. in. and powered by four to six-cylinder gasoline engines, are now offered. This equipment is mounted on steel skids or trucks. The size of the jet pipe generally varies from 2 to 4 in. nozzled to proper size at the lower end. Sometimes jet pipes of smaller sizes are used. Combinations of air and water jets are also sometimes used with good results. In some soils, one jet will do the work, while in other cases, two and even three may be necessary.

When only one jet is used, it should be shifted from one side of the pile to the opposite side as often as may be required to maintain the pile in proper position as it sinks into the ground. The jet pipe should be hung to a rope passing through a small snatch block attached to the driver leads and kept moving up and down or gradually lowered, depending on soil conditions. This may be done by hand, or mechanically with a winch head, but not from a hoisting drum. The jet nozzle is kept near the point of the pile. It is essential that the jet be kept in motion to prevent its freezing. Also, after the pile reaches a certain depth, the water will sometimes cease to flow around it, coming out on the surface of the ground some distance away and possibly around a pile driven previously. When this happens, the jet must be withdrawn immediately and started down again as quickly as possible to reestablish the stream of water along the pile.

In building falsework to support a railroad track during the construction of a combination grade separation and river bridge in Los Angeles, Cal., it was necessary to sink wood piles to depths of 30 to 40 ft. through hard packed gravel strewn with boulders 12 in. or more in size. The piles were placed by the use of a water jet and steam pile hammer. The jetting equipment consisted of a four-stage centrifugal pump driven by a six-cylinder gasoline engine, transmission connected. The pump delivered 300 gal. of water per minute at a pressure of 275 lb. per sq. in. A 3-in. jet pipe, nozzled to 1½ in. was used. Water was obtained from the city main through a special connection. After some experimenting, best results were obtained by first working the jet down its full length into the ground, allowing the water to flow for a short time. The jet was then withdrawn quickly; the pile placed in the leads and driving commenced at once. In some cases the pile was driven home without further jetting. In quicksand, this procedure has proven very effective.

Preboring

Experience clearly indicates that inability to obtain the desired pile penetration, in large measure, is due to using steam pile hammers of improper design and too light for the job requirements.

Regardless of the size and type of hammer that may be employed, there is a limit to the depth that piles can be driven and, if sufficient penetration can not be obtained, some other means of sinking the piles must be introduced. In many cases the only alternative is to preform holes for the piles. Although various methods have been employed, the work can be best done with a power-driven earth auger.

Post hole augers have been used to a limited extent for preboring work, but they are too slow and should be confined to jobs that are not large enough to justify more costly equipment.

Committee—W. F. Martens (chairman), gen. for. b. & b. & w. s., A. T. & S. F., San Bernardino, Cal.; J. F. Lockwood (vice chairman), supv., b. & b., C. & O., Richmond, Va.; C. F. Berg, engr. dftsmen, C. & N. W., Chicago; L. G. Byrd, supv., b. & b., M. P., Poplar Bluff, Mo.; B. J. Chamberlain, scale supv., C. & E. I., Danville, Ill.; R. L. Cook, asst. engr., M. P., Houston, Tex.; M. H. Dick, eastern editor, *Railway Engineering and Maintenance*, New York; F. G. Elmquist, br. insp., C. M. St. P. & P., Chicago; P. V. Elfstrom, dftsmen, C. & N. W., Chicago; L. I. Evans, instmnan, C. M. St. P. & P., Savanna, Ill.; O. M. Glander, ch. carp., C. M. St. P. & P., Mason City, Ia.; A. E. Kiles, b. & b. carp., S. P., El Paso, Tex.; J. B. Lodeski, asst. br. insp.,

C. & N. W., Chicago; J. F. Montgomery, supv., b. & b., St. L. & S. W., Tyler, Tex.; and E. E. Tanner, gen. supv. b. & b., N. Y., C., Albany, N. Y.

Discussion

Opening the discussion, G. S. Crites (B. & O.) mentioned that a committee of the American Railway Engineering Association has been working on a new pile-driving formula which he was certain would confirm the recommendations in the report with respect to the weight of hammer and speed of blow. A. R. Harris (C. & N.W.) asked Chairman Martens if he had ever used lodepole pine piling. Mr. Martens replied that such piling is not used on the Santa Fe, but that it can be used for falsework and in locations where it will be completely submerged, if one has the right kind of driving equipment.

R. E. Caudle (M.P.) cautioned against overdriving, and cited an example of two bridges driven in the same locality, one by a foreman and the other by an assistant foreman. The soil conditions, loam and packed sand, were similar at both bridges, he said, but at one of the bridges the piles were given 250 to 300 blows after refusal, producing small longitudinal cracks in the piles, while at the other the piles were not overdriven. The first bridge, he said, had to be renewed completely after 12 years, while the other was still in good condition after 21 years service.

Chairman Martens replied that about 85 per cent of overdriving is due to the use of inferior timber or too heavy a hammer for the job. In the latter case, he said, overdriving can be overcome by slowing down the hammer by means of the steam throttle. G. Lynn (C. & N.W.) said that the trouble is usually due to too high speed of the hammer, and cited his experience with a double-acting, 6800-lb. steam hammer. He said that when the pile begins to drive hard, the speed increases to as much as 130 blows per minute. When this occurs, he said, the steam pressure should be regulated to reduce the rate to about 90 blows per min., which will produce better results. He added that the piles must be watched carefully.

Chairman Martens warned that the bearing value of the piles must be watched closely, always assuming that 6, 8 or 10 ft. of the stream bed may be scoured away. He recommended that where the piles cannot be driven to sufficient penetration, pre-boring or jetting be used.

H. M. Church (C. & O.) inquired whether shortleaf and loblolly pine makes satisfactory piles if the wood is of close grain or suitably density,

to which Chairman Martens replied in the affirmative. Continuing, Mr. Church said that we are then safe in following specifications which call for close grain, or which specify density of wood, and added that in the use of shortleaf pines, he would prefer those with a deep layer of sap wood, so the treatment will provide good protection.

The discussion then turned to the decay of treated piling. J. S. Hancock (D. T. & I.) said that he had had trouble with decay starting at the top, in the hearts of piles, and stated that moisture must be kept out of the top. G. H. Holmes (M.P.) said that his road uses structural angles or splice bars, instead of drift bolts, to

avoid the starting of decay at this point. Mr. Church said that his road protects the tops of piles with several treatments of hot pitch and tar, and then applies a sheet of tar- or asphalt-saturated felt roofing, which method has been very successful. Mr. Lynn stated that he had found that roofing paper seals the tops of piles very well.

Preventing Accidents Among Bridge and Building Employees

Report of Committee

SAFETY is no new undertaking for the railroads. Early in this century some of the more important systems recognized with considerable concern the mounting lists of injuries and fatalities. At that time it was thought that railroad employment was particularly hazardous and that if some one lost a leg, an arm, or an eye, this went with the job.

Large industrial organizations were among the earliest to feel the necessity for safe workmen and long before this was generally recognized on the railroads, some industries had skeleton organizations to deal with such matters. While train service employees were the first to claim attention, owing to the more hazardous positions in which they might find themselves, shop and maintenance of way employees were gradually brought into the picture.

Accidents Taken for Granted

Early in accident prevention campaigns, the prevalence of accidents was recognized. Seldom was a train operated, a gang organized, or an engine serviced that it did not result in injury to some one. Accidents were taken more or less for granted and if one didn't get injured, he was regarded as lucky.

Safety campaigns have shown how fallacious this conclusion was. One of the first methods used in "no accident" campaigns was to list the accidents occurring during a given period, classify them, and endeavor to assign a cause or reason for each. Soon it was discovered that this was a tremendous task, particularly on properties which extended over a thousand or more miles, so district or division committees were formed. The special advantage of these small groups was personal contact with those injured. One of the primary objects in accident prevention is to obtain the facts in the case. Necessarily, to do this,



E. H. Barnhart
Chairman

quick contact is required. One's neighbor or friend working with him in the gang, the crew or at the bench, is in far better position to obtain the facts more quickly than anyone else. Hence we have the origin of worker representatives on safety committees.

Three "E's" Essential

As safety campaigns got into full swing, it quickly developed that, like the three "R's" in the little red school houses, three "E's" were essential if safety were to obtain a firm footing. First—"Engineering"—the car, the locomotive, the tool, the machine, the building, the platform—should be so safe, so guarded, or sufficiently removed from the operated track to prevent an accident. This is where the management functioned. It is surprising how many conditions of these classes were found and corrected on the American railroads.

Managements willingly co-operated with employees to bring about safe working conditions. Not all, were, or

could, be corrected, but a very small percentage remained and these were covered by precautionary measures. So thoroughly did managements enter into the spirit of correction that often many thousands of dollars were spent to secure results. Even today after more than 40 years of pioneering along this line, we still find unsafe conditions, which are corrected as they are found.

The second "E" has to do with "Education." Efficient workmen must also be safe workmen. They go hand in hand. To make a safe workman we must not only educate him along the line of his individual work, but must teach him how to do that work safely, for if it is not carried on safely it is not efficient.

The third "E" is "Enforcement." Safety rules must be enforced, not necessarily by drastic methods such as loss of time or discharge, but by ability to make an efficient, safe and successful workman out of an apparent failure. Think of the possible influence on a gang by a foreman with such ability.

Can We Prevent Accidents?

Prevention of accidents has been discussed as long as safety—but can we prevent accidents? Some say that accidents run in cycles. One territory will go for several months, or even years, without an accident, then suddenly, there will be a veritable epidemic of accidents. To what is this attributable? Whose responsibility is it? Let us go back and apply our three "E's." Certainly, if the management furnishes safe equipment, tools and machinery, it is not its responsibility. But the management is made up of human beings—our immediate superiors and those higher up. If the bosses are interested in safety, that interest, and to just that extent, will filter down to the humblest employees. So it is the officer's duty to show to em-

ployees his intense interest in safety and to insist upon safe and sane methods among them. It should not be forgotten that one unsafe man in a gang jeopardizes the lives of the whole gang. If this employee is not amenable to discipline, or will not practice safe methods, the responsibility rests with the officer to take such steps as will make the gang safe. Constant vigilance should be the rule of the officer. Safety should be uppermost in his mind and he should not hesitate to call it to the attention of his employees at all times.

Foreman Has Large Responsibility

The responsibility for the safety of workmen rests heavily upon the foreman or direct supervisor. His is the largest responsibility in the enforce-

them is written in some fellow-worker's blood. They were made rules in order to prevent a reoccurrence of the accident or accidents which resulted in the rule being promulgated. The foreman should be going over these rules constantly with his men, for it is only by continued repetition of such rules that they become fixed, and when fixed they become a habit. The newer and younger employees should especially be required to adhere strictly to these rules. The younger employee pays close attention, if he is interested in his work, to his fellow employee. If he sees that employee breaking one of the rules on safety and the foreman passes it without calling his attention to it, the work of perhaps weeks or months of education along safety lines is destroyed. The foreman should not permit even the slightest infraction of a safety rule, for if he does, he has lost a valuable asset in safety education.

Wholehearted Co-operation

In addition to the printed safety rules now almost universally used on the railroads, other bulletins and instructions are issued from time to time. How are these new instructions to be gotten before each man? The foreman is the only one to bring such instructions to the attention of his gang. Some foremen do this in a rather matter-of-fact way, and when they have done this they feel that they have completed a disagreeable task. How much attention do you think is paid to such presentation? How would it impress you if you were a new man? To bring any instructions forcibly to the attention of a gang, such instructions must have the whole-hearted cooperation and sympathy of the foreman in charge, and he must be able to impress upon the men the importance and necessity of complying with such rules.

Advice to the New Man

The foreman must be a leader and of such a personality as to impress his men. The younger men especially look to and admire leadership. The foreman who is a leader can hold his men, can obtain greater efficiency from his men, and can do work more safely than a weaker man. After all, efficiency and safety go together, for if work is done in an unsafe manner, it is not efficient, and, on the other hand, if the work is performed efficiently, then it is usually safe. More attention should be paid to new men entering the service, endeavoring to educate them along safe lines. One method of doing this is the practice on one road on which the new man is given a printed form in duplicate,

which he is required to read, sign both copies, and retain one. The form contains seven paragraphs and it is so pertinent that it is reprinted here:

(1) Your success in the service you are about to enter will depend upon the care you exercise in the discharge of your duties. The best record you can make, both for yourself and the company, is the record of a careful and safe man. You are not expected to take any unnecessary chances in the performance of duties.

(2) The problem of safety is not altogether a question of rules and their enforcement, safety appliances and their application; but the development of inherent, self-restraint and control. Safety is fundamentally a habit of mind which may be acquired by all through the exercise of ordinary caution and forethought in the small details of everyday duties.

(3) Safety must be the first consideration of every employee. Only employees who are thoughtful of the safety of themselves and others will be retained in the service. Those who violate the rules, or are careless will be discharged.

(4) Foremen will be held responsible for seeing to it that all persons applying for work receive and thoroughly read a copy of the safety rules and instructions before entering the service.

(5) When you accept employment or remain in the service, it is understood that you do so with the full knowledge of the hazards of railroad work, and that you agree to exercise due care in the performance of your duties to prevent accident or injury to yourself or others.

(6) You are required to report violations of the rules, as the safety of yourself and fellow-workers depend on their observance.

(7) Don't take chances! Remember to be careful under all circumstances. When caution becomes a methodical habit, there will be few injuries. Prevention of accidents is one of your most important duties. It is better to cause a little delay than to cause an accident, the memory of which may live with and distress you throughout the years to come.

Rule-a-Day

Another railroad has the following safety slogan: "Obey the operating and safety rules and you'll never get into trouble."

It is the practice on some roads, in order to keep the safety movement constantly before their employees, to designate one of the rules for each day—known as "Rule-a-Day." This particular rule is posted on bulletin boards, in shops, rest-houses and dormitories and read to gangs before the start of each day's work. The interest of the officer in seeing that this is done is paramount in the success of any such practice. Officers are too prone to have the instructions issued, and then promptly forget them. If the officer, when going through the shop or out on the train, or with a gang, does not take enough interest to ask concerning the safety rules, this practice will soon be discarded.

The measure of practically all work



"The Responsibility for the Safety of Workmen Rests Heavily Upon the Foreman"

ment of safety of any—outside the individual himself. If he is not constantly on the alert to detect and correct unsafe practices, an accident will soon result. The gang or shop that has the best safety record is that gang or shop where the foremen are safety-minded. This does not only mean that the foreman is safe individually, but that he is always talking and inculcating the habit into the minds of his men. The major responsibility of the foreman then lies in the education of his men along safety lines. This is particularly necessary at the present time when so many new and younger men are being employed. Older employees should be familiar with safety methods and have enough experience to practice such methods.

The management has certain safety rules which are to be obeyed. These rules are the result of bitter experience, for it is said that each one of

or successful practices today is by comparison. The units by which we judge efficiency and economy are by comparison. We compare one man with another, one division of a railroad with another, one gang or one shop with another. Local safety committee's work, too, is compared with that of other committees, and thus sharp competition is set up which often produces good results. So it is very conducive to the safety movement to co-ordinate the activities of the various local committees and arouse a spirit of competition and strive to obtain the best safety records.

The primary work of the safety agent should be directed along these lines. He can show how certain practices, while probably not in direct violation of any specific safety rule, did result in an accident, and thus possibly prevent a reoccurrence of a similar accident. Talks during noon hours at the shops or at specially appointed safety rallies serve to keep constantly before the men the importance of the safety movement.

Physical Examinations

During these days of difficulty of obtaining men and consequent loss of experienced men, the question of the physical examination of employees before entering the service is a live one. Some roads have waived or are now considering waiving such examinations in order to obtain the necessary help. There are two primary dangers in such action—first, the very real probability of bringing into railroad service men with seriously diseased minds or bodies, who will prove a grave set back to the safety movement—and second, the possibility of suits against the company in efforts to secure large sums of money.

The close observance of the old, but ever true, saying, "A sound mind in a sound body" was never more necessary than it is today. Railroad work in nearly all departments today is hazardous at the best. This is more particularly true in the bridge and building department where work now must be done with machines and under considerably increased traffic. It requires the mental alertness of every individual and correct planning by the foreman. One who has a mind dulled by disease, or other causes, has no right to jeopardize his fellow employees.

Home conditions, too, play a large part in the man's attention to his work. If the employee has family troubles, he cannot help but carry them, to a certain extent, to his work. Under present day conditions it is imperative that each individual have

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his mind 100 per cent on his work. This is doubly true of the foreman, for he has not only the responsibility of planning the work, but also of seeing that each individual understands just what his part of the work is and when he is to function. Too many accidents have been caused by improper team work or ignorance of the sequence of the various steps in the operation.

All labor organizations and a vast majority of employers have long recognized that man is not a machine. To do his most efficient work safely, he must be alert and quick to make decisions. The mind or body dulled by fatigue or near exhaustion is a menace to the company as well as to himself and his fellow employees. Long hours of work-producing fatigue, have, therefore, long since been recognized as a detriment to good work. In emergencies, such as floods, fires, etc., necessary provision should be made for rest periods to avoid the possibility of serious accidents.

Handling Materials

The handling of materials constitutes a large part of the work of the bridge and building department. Usually these materials are large and heavy, requiring special tools, machines and knowledge of handling. In this special task, "team work," more than anything else, is required. So many accidents in handling materials are traceable directly to misunderstanding among the men as to how the material is to be handled, when and how to take hold of a piece of timber and when and how to let go.



Handling Heavy Bridge and Building Materials Safely Requires "Team Work"

Here is where the wide-awake, alert foreman comes in. This becomes one of the particular duties of the foreman in handling men properly.

When heavy material is being handled, the foreman should be with his men to direct them and to be sure that every man understands perfectly his part in the operation. Some gangs have acquired that perfect team work so essential in doing this work, that they go along day after day without an accident; others have accidents almost every time they are called upon to handle material. This in large measure is chargeable to the foreman and he should recognize his responsibility in this respect.

Other Causes of Accidents

All roads require safe tools as a prerequisite to good work. Here again it is the foreman's direct responsibility to see that the tools his men are using are safe. This requires almost daily inspection of those tools, particularly those having striking faces. Inspection of the handles of all tools to see that there are no broken, split, or cracked handles which might cause injury is essential. Tools with sharp edges should receive particular attention so that they will be in shape for proper use. A dull tool can cause an accident, either to the user or his adjacent workmen. So many operations today, especially in steel work, make it mandatory to use goggles as protection for the eye that entire gangs should be so equipped. The foreman should see that he has the proper number of goggles and that the men wear them in operations that might cause an eye injury.

The breaking of cables, ropes and hooks is another source of potential injury. Ropes that are allowed to lie around on the floor or other damp places for a long time and are then used for scaffolding are very likely to cause injury. Ropes, when carried as part of the equipment, should receive special care, and after they are old they should not be used where they are required to support men. Inspection of wire cables is very important. A broken strand or two is an invitation to an injury if it is required to support weight. The manner of constructing wood scaffolding is a potential cause for accident. Inspection of the support boards for wind shakes, knots, etc., is very important.

Shields and screens to prevent workmen from getting caught in moving parts of machines are almost universally provided. There are conditions, sometimes, where such safeguards are not provided. Foremen should caution workmen using ma-

chines under such conditions, for by this means, injury may be prevented.

Bridge and building men are often called upon to use inflammables and explosives. Practically every railroad has rules devoted to the safe manner in which such materials should be handled. If these are not known to the workman, or he has not handled such materials for a considerable period, he should familiarize himself with these rules before attempting to handle these materials. The foreman should see that the employee does know how such things should be handled.

Again, bridge and building employees are often called upon to work along heavily traveled highways; at crossings involving these highways; in connection with the erection of high-tension power lines; or in supporting traffic in connection with highways. Too much stress cannot be laid upon the grave responsibility of the foreman in planning and carrying out such work. Barricades and flagmen are quite often necessary to protect the gang properly. Alert, intelligent men from the gang who are thoroughly familiar with the operating rules should be selected as flagmen. Even by such selection, the foreman's responsibility does not end, for he should instruct the man in detail how to do the flagging and make him repeat these instructions to satisfy himself that the flagman understands what he is to do. Many near-accidents have been caused by flagmen not being properly instructed before they are sent out. The employee selected to do the flagging should also recognize his responsibility. Sometimes the lives of the entire gang are entrusted to him. If he is not absolutely certain of all the details required of him, he should not undertake the job until he is sure. This is particularly true in floods, fires, sinks or other catastrophes which may put the track or tracks out of service, or necessitate a very material reduction in the normal speed of trains.

To those who are intensely interested in the causes and prevention of accidents, aside from those directly concerned with the safety movement, the question often arises whether there will ever be a time when we can develop and remove the causes of all accidents. So long as the human element is involved in such accidents, it seems hardly probable that we will attain complete perfection. Only by constant application and attention to our work can we hope to minimize and reduce the causes for accidents to as near zero as possible. The safety movement is a constant, continual and every-moment proposition. Interest

in it cannot be relaxed for a single moment, or we may find ourselves reducing to zero the work of months and years of education and vigilance.

Conclusions

While the safety movement on the railroads is of comparatively recent origin, certainly within the present century, statistics prove that its development has been a profitable undertaking. The railroads have secured more efficient and better work owing to the conservation of trained manpower, thus resulting in the more efficient execution of work and consequent increase in net revenue from the property.

From the worker's point of view, it has proved more than profitable, resulting in continued and constant employment under much better working conditions, thus permitting him to better provide for his family, and thereby assist in raising the American standard of living.

Then, too, the State has a vital interest in the movement and has profited tremendously thereby. The family of the fatally injured employee often became a subject of public charity or dependent upon the State for sustenance. The large reduction in the number of fatal accidents, or loss of arms, legs or eyes which can be traced to safety campaigns has resulted in less public charity.

Safety is a two-fold problem—management and men. Unless officers are constantly and continually interested in the safety movement, it will lag, resulting in an increase in accidents. Primarily the heaviest responsibility rests upon the individual and the direct supervisory officer—the foreman. No other one person can do so much to promote safety and bring accidents to the much coveted goal—Zero—than the foreman. He can even do more than the individual, as a slip-up by him may result in injury to several in the gang. In planning the work, in handling materials required in carrying out the work, and in the actual performance of the work, he should be wide-awake and "on the job" every minute. The foreman must also be a leader and have such training that the men will recognize his ability in leadership. In the final analysis, the individual workman must be intensely interested in his own work so that he will *want* to do his work safely and efficiently, and in such a manner that there will be no injury to himself or his fellow workers. Education of the individual by the foreman so that the safe manner shall become a habit with the workman, and constant and continued stressing of safe methods, are the two

main essentials of producing "no accidents."

To obtain the best results in preventing accidents in the bridge and building department, as well as all other departments of the railroad, every employee, supervisor and officer should subscribe rigidly to the four following simple statements.

- (1) Obey the rules and regulations of the railroad.
- (2) Safety is of FIRST importance in the discharge of duty.
- (3) Obedience to the rules is essential to safety.
- (4) Use extreme care in every detail of work to prevent injury to self or others.

If every individual will follow these four rules faithfully and rigidly in all of their minute details, and to their fullest interpretation, the goal of every safety campaign—Zero in accidents—will be attained.

Committee—E. H. Barnhart (chairman), div. engr., B. & O., Garrett, Ind.; W. A. Batey (vice-chairman), sys. br. insp., U. P., Omaha, Neb.; L. D. Garis (vice-chairman), asst. gen. br. insp., C. & N. W., Chicago; J. C. Bird, b. & b., insp., N. Y. C., Corning, N. Y.; W. W. Gaines, br. insp., C. & O., St. Albans, W. Va.; A. G. Dorland, asst. engr., E. J. & E., Joliet, Ill.; C. C. Eubank, rodman, C. & O., Huntington, W. Va.; K. Hallock, supv. b. & b., C. & N. W., Fremont, Neb.; G. H. Holmes, supv., b. & b., M. P., Falls City, Neb.; E. H. Johnson, div. engr., C. M. St. P. & P., Miles City, Mont.; W. E. Maley, mast. carp., B. & O., Punxsutawney, Pa.; C. O. Sathre, asst. b. & b. supv., C. & N. W., W. Chicago, Ill.; J. W. Secker, sys. bldg. insp., C. M. St. P. & P., Chicago; H. E. Smith, engr. mtce., G. H. & H., Galveston, Tex.; and W. A. Sweet, gen. for., A. T. & S. F., Newton, Kan.

Discussion

A. Chinn (Alton) believed that, aside from all other considerations, bridge and building forces should follow safety practices consistently during the present period of national stress to conserve manpower. To do this they should not only practice safety and think safety; they should go beyond this and think danger. He endorsed everything contained in the report, saying that while every man is born with an instinct for self protection or self preservation (safety) he has no inherent knowledge of the means by which he can protect himself, and it is only through rather intensive education and the continual application of safety rules that safe action can be made automatic, as it must to be effective.

He then commented on the E's in the report, saying that it has been his observation that too much stress has been placed on Engineering and not enough on Education. "We ap-

pear to be sadly lacking in education," said he, "when an analysis of accidents shows that only 15 per cent of them result from faulty engineering while 85 per cent can be attributed to lack of or a faulty education. He also observed that it is possible to stifle safety consciousness by surrounding men with too many safety devices, that is, if they are placed in situations where the protection is not operative they are likely to take no precautions of their own. In a perusal of a considerable number of accident reports he had been struck by a repetition of the phrase, 'I didn't think' as the opening statement of the victim or of the person who had caused the accident.

G. S. Crites (B. & O.) advocated the use of record cards that would show the immunity from accidents of gangs and their foremen, who have desirable accident records.

W. A. Huckstep (M.P.) called attention to a hazard connected with portable fire extinguishers which should be given serious consideration, saying that a saboteur could, by forcing a wad of chewing gum into the nozzle of the extinguisher, cause a

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violent explosion because the pressure in the extinguisher builds up to a high point very quickly when it is put into action. In this connection, L. G. Byrd (M.P.) recommended that the seals and the filling of fire extinguishers be checked carefully to insure that gasoline or other inflammable liquid has not replaced the normal water content.

Mr. Byrd also called attention to the fact that more accidents occur among the older men in bridge and building gangs than among the newer men. He also emphasized that the training of men in safety does more to eliminate accidents than any other course of action. He said that when he is with a gang containing one or more new men he makes it a practice to impress upon them the importance of safety practices. He also emphasized the necessity for keeping after the older men constantly to see that they do not violate safety rules or fall into hazardous practices.

On his road, said Mr. Byrd, the management has instructed that one safety rule be read to the gang before starting to work every day. This rule is selected for the foreman, but

the foreman also picks out and reads another rule that pertains to the work that is to be done that day. In addition to this, the foreman appoints a safety captain for the gang, who serves a full week, and who is expected to watch the men for violation of safety practices during his tenure of office. This activity is rotated, every man in the gang being required to hold this office in succession.

Mr. Crites observed that most foremen are inclined to supervise the newer men more carefully than they do the older men, on the assumption that the older men, being well grounded in and thoroughly familiar with safety rules and practices, know the routine requirements of the work and do not, therefore, need so much attention. Mr. Barnhart (chairman) considered it an indictment of the foreman and of his management of the gang if the older men are hurt.

G. H. Holmes (M.P.) stated that he makes an investigation of every accident, no matter how small, if time is lost by any member of the gang, not only to determine why and how they happen, but also as a deterrent to the occurrence of future injuries.

Rail Fastenings on Bridges, Pits and Turntables

Report of Committee

THIS report was developed chiefly from information obtained from members of the association by means of a questionnaire, replies being received from railroads aggregating 135,000 miles of lines.

In considering the subject of rail fastenings on bridges, pits and turntables, the method of supporting the rail on the structure and the anchorage of this support to the structure assume major importance. It is imperative that the rail have an adequate and well-anchored support, otherwise any type of rail fastening will prove unsatisfactory.

One of the most satisfactory methods of supporting track over bridges is by means of a well drained ballast deck. Such construction gives riding qualities similar to the track on the embankment, which is highly desirable. Also, the track is maintained by the regular track forces, which is a distinct advantage. For construction of this kind, the rail supports and fastenings are the same as on the approaches.

On open-deck bridges the use of the time-tested timber bridge tie is still the most satisfactory method of supporting and fastening the rail.

It is apparent that the railroads are not in exact agreement as to size and spacing, method of dapping, or practically any other detail of bridge ties. Railroads using similar equipment and with similar train speeds apparently derive equal satisfaction from different standards. This difference in



John S. Hancock
Chairman

standards is due to the personal ideas of those responsible for the construction and maintenance of the bridges, as well as the experience of these men, and also, to a certain extent, at least, to the financial condition of the various railroads.

Size of Bridge Ties

The size of ties for open-deck steel bridges varies, of course, with the center-to-center spacing of the stringers or girders supporting the ties and the live load weight to be supported. Tie spacing is not subject to much variation because, if spaced too far apart, the ties will tend to bunch in a derailment due to the wheels dropping down too far below the tops of the ties, while, if spaced fairly close together, the wheel flanges will tend to run along on top of the ties without dropping down enough to force the ties to bunch. Oak bridge ties with a 6-in. clear spacing between ties have carried derailed cars across the full length of sizable bridges without bunching the ties.

The Chicago Great Western designs its ties in accordance with A.R.E.A. specifications, distributing the wheel

load equally over three ties, impact not considered. For other than standard construction, one railroad designs for full wheel loading, with one tie taking 50 percent of the load and the adjacent ties each taking 25 percent of the load, impact not considered.

Preframing Bridge Ties

When ties are framed before treatment for either steel or timber structures, several details must be considered. For steel structures, the exact width of the steel flanges can be determined in the field or from plans. Field measurements, however, are preferable. On timber bridges, the width of dap will depend upon whether the timber stringers are S4S or rough dressed. Rough dressed stringers may over-run as much as $\frac{1}{4}$ in. each, and allowance must be made for this over-run. If ties are to be prebored for track spikes on new construction, the steel must be set on the correct centerline; otherwise the track will be out of line. On existing structures, the correct centerline must be marked on the old ties, field measurement taken to the steel flanges from this centerline and the ties framed accordingly. Each tie is then numbered as to its correct location.

On steel structures, no railroad reported dapping more than $\frac{1}{2}$ in. wider than the steel flange, and some allow a total of only $\frac{1}{4}$ in. wider than the flange. Where a wide dap is used, alternate ties should be driven tight against the steel flange in opposite directions before the rail is spiked, provided the ties are not prebored for track spikes. If ties are not dapped for rivet heads, these rivet heads, depressed into the tie, will assist in holding the tie to line. By careful field measurements and accurate shop framing, close fitting prebored ties can be obtained and are recommended if creosoted ties are to be used.

A tolerance of $\frac{1}{16}$ in. is usually the maximum permitted in the depth of tie dap required. Mill framing is highly desirable, because of the accuracy of such work. However, several railroads still permit hand dapping.

When using dapped ties on steelwork, most railroads use $\frac{3}{4}$ in. or $\frac{7}{8}$ in. hook bolts in every third or fourth tie to anchor the ties to the steelwork. Also, on timber trestles, dapped ties are usually bolted, drifted or spiked to the wood stringers at every third or fourth tie. However, at least three railroads depend entirely upon the tie dap to anchor the ties on both steel and timber structures. The use of hook bolts or equal devices on steel, and drifts, bolts or spikes on timber trestles, gives additional sta-

bility to the dapped tie deck that is particularly desirable in case of a derailment.

The Chicago, Milwaukee, St. Paul and Pacific reports some dissatisfaction with hook bolts to anchor ties to steelwork and now use a proprietary type of bolt with a lug washer and double coil steel spring. With undapped ties on steelwork, every second tie is anchored on tangents and every tie on curves. However, a few railroads anchor-bolt only every third or fourth undapped tie to the steelwork. For undapped ties on timber trestles, the Baltimore & Ohio spikes one end of every tie on tangents, alternating the ends of adjacent ties, and spike both ends of the tie on curved track, using $\frac{1}{2}$ in. by 12 in. boat spikes. The Illinois Central makes every sixth tie a key tie on both steel and timber structures, this key tie being 2 in. deeper than the intermediate dressed ties. The key ties are dapped 2 in. to engage the steel flanges or timber stringers. On steel bridges, these key ties are hook-bolted to the steelwork, and on timber trestles they are bolted to the stringers. For timber trestles, the Canadian Pacific spikes each tie to the outer stringer with $\frac{3}{4}$ in. spikes. Also, ties over bents are bolted to the caps.

The bolting, drifting or spiking of ties to stringers is an unsatisfactory detail that no one has, as yet, corrected except by complete elimination. It is hardly practical to prebore the stringers, for this hardware and the use of such hardware without preboring provides an entrance for water and fungus into the untreated portion of the stringer. Until this detail is improved, the best that we can do is to use the outside stringer for this hardware in order that the removal of decayed stringers, when necessary, will not be unduly difficult.

Where there are only two lines of rivet heads in the cover plates, ties may be dapped for rivet heads. However, with four lines of rivets, such dapping seems impractical. Many railroads report no dapping for rivet heads, permitting the first train over the structure to settle the rivet heads into the timber, slowing the train down to 10 to 15 miles an hour. For pine and fir ties, which are widely used, this is a very effective way to take care of rivet heads, as dapping them is expensive and decreases the strength of the tie. Oak ties, however, may require more than one train to settle the rivet heads into the timber.

Fastening Ties to Stringers

The Michigan Central prefers to dap for each rivet head, which in some cases precludes framing before

treatment, or else cutting grooves the full width of the tie for each rivet line, as it considers that rivet heads will not sink readily into the timber, particularly if the timber is somewhat knotty. The Canadian Pacific; Chicago, Rock Island & Pacific; Northern Pacific; Chicago, Milwaukee, St. Paul & Pacific; Great Northern; Chicago, Great Western; Detroit, Toledo & Ironton; Missouri-Kansas-Texas; Elgin, Joliet & Eastern and Chesapeake & Ohio do not dap for rivet heads, permitting a locomotive crane or the first train over the bridge, at reduced speed, to press the rivet heads into the tie. For this practice the track must be securely anchored to line as there is a tendency for the track to shift on rivet heads, and if the track is once seated out of line, it is difficult to restore it to correct line.

The New York Central; Canadian Pacific; Chicago, Rock Island & Pacific; Illinois Central; Chicago, Milwaukee, St. Paul & Pacific; Pennsylvania; Baltimore & Ohio; Missouri-Kansas-Texas; Delaware & Hudson; Erie; Chesapeake & Ohio and Detroit, Toledo & Ironton frame and bore timber partially or completely before treatment. Several roads omit preboring of creosoted ties for track spikes. However, it is believed to be practicable and economical to prebore for track spikes as the additional penetration of creosote at the point where the tie is most severely used will materially increase the life of the tie.

Many tie plates are so designed that the center of rail lies inside the centerline of the plate. The plate then tends to settle into the tie more deeply at the inside edge than at the outside edge, insuring tight rather than loose-gage track. In using 112-lb. rail, one railroad reports preboring and spiking the track $\frac{1}{8}$ in. wider than standard gage to eliminate tight gage track. No other railroads, however, prebore for other than standard gage and obtain satisfactory results.

Most of the railroads reporting place bridge ties without interruption to traffic, except for slow orders during working hours, generally replacing all ties at one operation, although an occasional spotting in of a new tie to replace a defective one is permitted until a complete out-of-face renewal is required or justified. The patching in of ties tends to make a rough track.

Hand derricks mounted on push cars are very useful in placing ties. Maintenance cranes and locomotive cranes assist in speeding up the work and air or electric wrenches or drills are very efficient and highly desirable tools in speeding up the work.

Most railroads change out ties during both summer and winter. However, some confine this work to the

winter months, leaving the summer for work not suitable for cold weather. One objection to changing ties in winter is that frequently the top flanges of steel structures are damp and cannot be coated properly. In the Arizona, New Mexico and Nevada territories, where the temperature gets much over 100 deg., tie renewals are scheduled to avoid these periods of the year.

No major difficulties are reported during the process of replacing ties. Good practice requires the placing of a slow order to protect the workmen and operation of trains. The Milwaukee railway slows trains down to about half the normal speed. The New York Central does not issue a slow order except on major structures, when a bulletin is issued covering certain working hours, during which time a flagman is used. During other hours, track is left in condition for usual speeds. Local conditions, of course, determine the protection and speed requirements at the time of the renewals. In multiple-track territory on large structures, it is desirable that service be taken off the track on which ties are being replaced.

On steel structures having a camber approximately equal to the deflection caused by the train loading, bridge ties may be dapped or framed the same depth for the full length of the steel. It will be found, however, that some spans have considerably more camber than will be deflected out by the train loading, in which case it is possible to obtain better riding track by removing excess camber in the tie framing.

The Missouri Pacific has for some time butt-welded the rail on all open-deck bridges at such time as new rail is laid over the structure and finds this practicable on heavy and high-speed lines. Welded joints should add materially to the riding qualities of the track and reduce impact stresses in the bridge structure.

The Milwaukee reports that, as open-deck floors come up for renewal on its main lines where traffic is heavy and fast, they are replaced, if possible, with creosoted-timber ballasted floors.

Tie Plates and Spiking

All railroads report the use of tie plates on open-deck bridges similar to those used on embankments. For heavier rail, double-shoulder plates are in universal use.

In considering the size of tie plates, the A.R.E.A. Manual contains plans for plates 11 in. long for 112-lb. RE rail and 12 in. long for 131-lb. RE rail. However, in 1942, the committee reported that a recent canvass of the railroads indicates that a 12-in. plate for 112-lb. RE rail and a 14-in. plate for 131-lb. RE rail most nearly meet

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requirements of the roads contacted.

For holding track to gage, the hold-down spike is more effective than the rail-holding spike. These hold-down spikes are also very effective in preventing plates from shifting on the ties, which adds materially to the life of the ties, as this shifting of the tie plate is an important factor in the mechanical wear of ties. Due to the deflection or working of the rail, the rail spikes are partially withdrawn from the tie and the spike holes for the rail spikes are subject to considerable wear, decreasing the effectiveness of rail spikes. Since the head of the rail spike is somewhat above the base of the rail, due to the working of the rail, it offers less resistance to horizontal movement of the rail than the hold-down spike whose head is driven

hold the plate tight against the tie. Such spring washers also decrease the tendency of the spike to tear out the wood fibres holding the spike, which adds much to the value of the spike, for when the wood fibre surrounding the thread is once damaged, the screw spike loses its effectiveness.

Replies to our questionnaire indicate that not many railroads are using special type fastenings, but those which do, express satisfaction with their use. In general, however, the opinion is that the benefits to be derived from special type fastenings are not commensurate with the increase in the first cost except when used for special installations.

Rails Fastened Direct to Decks

One of the most important and recent developments in track fastenings is the anchorage of the rail direct to steel and concrete structures on main-line high-speed tracks. Not many of the railroads replying to our questionnaire have had experience with this type of fastening on main line tracks. Much detailed information has been published recently on this development, however, and, as this information is readily available to anyone concerned and is published in more detail than it would be possible to include in this report, we will make no effort to duplicate it here.

C. P. Disney, bridge engineer of the Central region of the Canadian National, is a pioneer in the development of an excellent fastening for securing rail direct to main-line bridge decks by means of heavy malleable iron rail plates or chairs and clips. In this design the heads of the $\frac{7}{8}$ -in. by $3\frac{1}{2}$ -in. bolts securing the rail clips to the rail plate are countersunk in the rail plate and the 1-in. diameter bolts anchoring the rail plate to the concrete have no contact with the rail. A $6\frac{3}{4}$ -in. by $\frac{1}{4}$ -in. by $12\frac{1}{4}$ -in. rubber shim, with $\frac{1}{2}$ -in. round holes for the 1-in. hold-down bolts, is placed between the concrete and the rail plate as an insulation to prevent short circuiting on signal track. In a letter dated February 23, 1942, Mr. Disney writes: "After 20 years' experience, I can state definitely that there is only one satisfactory method of attaching rails directly to concrete or steel decks, and that is by the use of a well-designed heavy malleable iron plate and clips. This method has proven 100 percent satisfactory. We have hundreds of bridges with this type of deck, and in no instance have we had a suggestion of trouble or failure of any portion of the installation. Once it is installed, it apparently is permanent and requires no maintenance whatsoever." Mr. Disney also



The Canadian National Was a Pioneer in the Use of Heavy Malleable Iron Plates and Clips for Fastening the Rails Directly to Concrete Bridge Decks

tight against the plate. The holes in the plates for the hold-down spikes fit more tightly than those for rail spikes, permitting both hold-down spikes to resist better the tendency of the track to spread. The ratio of resistance of hold-down spikes to rail spikes in preventing the spreading of track increases with the life of the tie as the rail spike gradually loses its holding power in the wood.

Screw spikes are very effective as hold-down spikes. They are, however, more expensive to install and maintain and require additional special tools for their installation and maintenance. The heads of the screw spikes also tend to corrode to the extent that they do not fit the wrench socket and the threads sometimes freeze in the wood so that they cannot be tightened without breakage. In using screw spikes as hold-down spikes, it is recommended that double coil spring washers be placed between the plate and the head of the screw spike to take up the withdrawal action and

advises that this type of fastening has been used at a number of points to secure their rail on engine pits and the circle rail on turntables.

Advantages

Although there are disadvantages in anchoring rail directly to steel or concrete decks, it is believed that for ordinary construction, the advantages may quite often outweigh the disadvantages, and for special construction, where many adjacent tracks have to be elevated to accommodate a grade separation structure, economy demands the anchorage of the rail direct to the bridge deck. The main advantages of this type of rail support are:

(1) A saving of 15 in. to 18 in. in the headroom ordinarily required for ballast and ties. This can be particularly important on grade separation structures in cities or at locations adjacent to yard tracks where large-scale track raising or lowering of city streets, drains and sewers are involved.

(2) No timber ties to be renewed or tamping of track or cleaning of ballast required.

(3) Better drainage of the bridge slab.

(4) No accumulation of dirt on the track as the concrete surface can be kept clean by sweeping or washing.

(5) A marked saving in the cost of the main span due to the elimination of the ties and ballast, thereby decreasing materially the dead load to be carried by the structure.

Some of the disadvantages advanced for this type of construction are:

(1) Care is required to set embedded type anchor bolts for the plates to give good track alignment, and their location so they will not touch the reinforcing steel. The Canadian National reports that they have no difficulty in placing these bolts as they now use a cinch $\frac{1}{4}$ -in. drill the holes for these bolts while the concrete is still green.

(2) Different riding qualities of the track on the bridge as compared with adjacent ballast sections.

(3) Difficult to change alignment or grade of track after the bridge is constructed.

On a Grand Trunk railroad structure built recently at Flint, Mich. where this type of fastening was used, a reinforced concrete sub-ballast transition slab, 10 ft. wide by 12 in. thick and 12 ft. long, was placed at each end of the bridge, with its forward end resting on a concrete shelf one foot wide at the back of each abutment, and the other end resting on crushed stone ballast. Also, to ac-

commodate the greater wave motion of the rail near the abutments, rail bolts for the first few plates on the slab were not tightened as much as the remainder of the rail bolts on the slab. Rail plates on this structure were placed at 21-in. centers to accommodate 100-lb. R.A. rail. The rail of one track over this structure was welded continuous over the bridge, standard joint bars being also installed at the joints. The rail in the other track is not welded, having standard joint bar connections, this in order to secure a comparison of the riding qualities of the two types of joints. To date no distinct difference is apparent in the behavior of the two types. As this structure is located in automatic signal territory, a careful check was made to determine if there was any tendency towards signal current leakage but in no case was leakage of electrical current detected.

For those of us who have had several years' experience in maintaining concrete structures that have been in service for 15 years or more, there arises the question as to what will be the satisfactory life of a comparatively thin concrete deck that is not waterproofed 100 percent, and whether track anchorages secured in slabs that are not waterproofed will prove satisfactory over a long period of time. It has been necessary to remove disintegrated concrete from grade separation sidewalk slabs that were not waterproofed and were subject to frequent freezing and thawing weather, both top and bottom. The concrete forming the deck slabs on these same bridges was built of the same concrete as the sidewalk slabs. However, these deck slabs were well waterproofed with standard two-ply asphalt-saturated cotton fabric laid in hot asphalt, and to date no apparent disintegration has taken place in these slabs. It is evident that the life of rail chairs or plates anchored to steel decks will depend upon the life of the fastenings and steel involved. However, when secured to a concrete deck, their life might be limited to the life of the concrete to which they were anchored. For those who consider anchoring rail direct to concrete, it is recommended that they give serious consideration to thoroughly waterproofing the deck slab if it is to be subject to snow and ice with frequent freezing and thawing.

Concrete, as now used, is a porous material and will absorb approximately 10 percent of water by volume. The freezing of this absorbed water causes spalling of the concrete. Much research is now in progress to eliminate this trouble, particularly by the state highway departments. A few states are using a new type of cement

in their pavements to prevent this scaling and spalling. Others are experimenting with a surface waterproofing like boiled linseed oil. However, so far, this is experimental. Until such time as concrete is made more resistant to weathering and freezing and thawing, we are of the opinion that any flat concrete surfaces that will retain snow and water, to which track fastenings are attached, should be well waterproofed. However, here again, we must admit that the Canadian National reports that they do not waterproof their bridge slabs and that they have had no trouble with their type fastenings due to disintegrated concrete over a 20-yr. period.

For locations requiring the installation of a flat timber on pit walls or bridges, the track being fastened to the timber with standard track fastenings, an 8-in. by 16-in. creosoted timber placed flat has proven satisfactory, the timber being anchored to the wall or deck by 6-in. by 4-in. angles, one on each side of the timber with the 6-in. leg up, the timber being secured to the angle iron with $\frac{3}{4}$ -in. by 6-in. lag screws spaced to clear the track spikes. The 4-in. leg of the angle is anchored to the wall or deck by bolting.

The Milwaukee and the North Western report the use of a proprietary type of fastenings for anchoring rail direct to steel bridge decks. They have experienced some trouble in securing perfect insulation between the rail and the steel in signal territory and trouble in shimming when required to bring the track up to surface.

Engine and Cinder Pits

Track can be anchored adequately to steel and concrete pit walls in many different ways.

On engine pit walls, the Chesapeake & Ohio uses 8-in. by 1-in. by 12-in. bearing plates laid directly on top of the pit walls at 18-in. centers for 100-lb. rail. The rail is secured to the bearing plate by heavy rail clips. Bearing plate and rail clips are secured by $\frac{3}{4}$ -in. V-stirrup bolts imbedded 16 in. into the concrete wall. For slow-speed tangent track, anchorages like or similar to the above are giving satisfactory service and have the advantage of being low in first cost. The C. & O. bearing plate is 1 in. thick, which is heavier than most railroads use. However, the 1-in. plate was adopted because of trouble with thinner plates. Most of the trouble from this type of anchorage is caused by too small and too light bearing plates, or bearing plates spaced too far apart, overloading the concrete and causing it to crack and spall.

Bolts $\frac{3}{4}$ in. in diameter are believed to be a little too light for anchor bolts. A $\frac{7}{8}$ -in. bolt, we believe, is more satisfactory and the C. & O. tentative design calls for 1-in. bolts. However, for more severe conditions, as on curves or higher speed tracks, anchorage similar to that adopted by the Canadian National should prove more satisfactory, owing to its sturdiness and flexibility, with a corresponding increase in initial cost.

Although several railroads imbed structural steel shapes, castings, bearing plates, etc., in concrete walls, it is believed to be more practicable to rest such steelwork directly on the concrete than it is to imbed all or any part of it in the concrete, particularly on outside construction. It is difficult to pour concrete so it will engage wide surfaces like flanges of steel beams without slight voids adjacent to the steel. Also, concrete may shrink sufficiently to leave voids adjacent to the steel. Such voids on outside construction tend to collect moisture that, with freezing and thawing, disintegrates the concrete. Also, as there is no flexibility in concrete, any steelwork encased must have sufficient strength, rigidity and anchorage to withstand the loads and thrusts without movement; otherwise, adjacent concrete is liable to be damaged. Also, in imbedding structural steel in concrete, the concrete is divided into two sections, thus weakening the concrete. If steel is solidly embedded in concrete, it should be so placed and anchored and the concrete so reinforced that the resulting combination will take all loads and thrusts without movement. It is noted, however, that two railroads encase short rails in their pit wall concrete, with the base up, and weld the running rails to the bases of these short inverted rails, and report this construction as being satisfactory.

To secure rail direct to wide-flange steel beams on coal trestles, the Michigan Central uses a two-piece clip, consisting of a 5-in. by $\frac{1}{2}$ -in. by 6-in. steel plate clip secured to the wide-flange beam with two $\frac{3}{4}$ -in. by $3\frac{1}{4}$ -in. bolts, double nutted. A 3-in. by $5\frac{1}{16}$ -in. by 6-in. filler plate is placed under the outer 3 in. of the $\frac{1}{2}$ -in. clip plate as a filler approximately the height of the rail flange, with two bolt holes matched with the upper clip plate. The clip plate is bent slightly to conform with the slope of the rail flange and the corner engaging the rail is ground to fit the fillet of the rail. The clips are spaced on about 18 in. centers and are staggered $1\frac{1}{2}$ in. to avoid holes being in line in the wide-flange girder.

The Elgin, Joliet & Eastern uses a similar 2-bolt clip, consisting of a

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5-in. by $\frac{1}{2}$ -in. by $6\frac{1}{2}$ -in. rail clip with a $2\frac{3}{4}$ -in. by $\frac{1}{2}$ -in. by $6\frac{1}{2}$ -in. filler, using two $\frac{3}{4}$ -in. bolts. However, the Elgin, Joliet & Eastern does not make a bend in the $\frac{1}{2}$ -in. clip plate to fit the slope of the rail, using clip bolts to pull the clip plate into tight contact with the rail.

When rail clips, hook bolts or any other type of fastenings are used to secure the rail to steel or concrete, cognizance must be taken of the fact that the steel or concrete to which rail is secured must be securely anchored against spreading. Any ties, rods or



Channel-Shaped Castings and Bolt Assembly Used to Fasten Rails to Pit Walls

diaphragms placed to keep steel girders from spreading should either engage the top flange of the girder or the web of the girder as close as possible to the top flange. No standard spacing for such tie rods or diaphragms can be given as the spacing depends upon the lateral stability of the supporting beams; i.e., the lighter the supporting beams, the closer must be the spacing of the tie rods or diaphragms.

On timber coal trestles, or similar construction, where the speed is slow and the track tangent, a full length tie every four feet is considered adequate to keep the rail to gage, the intermediate ties supporting the rail being tie blocks of approximately the same length as the width of the timber stringers. As walks are usually required on this type of construction, the long tie at four-foot centers furnishes a good support for the walks and railing.

On cinder pits, the anchorage on the masonry wall side may be the same type as is used on engine pit walls. However, owing to severe rust action, they should be heavier to insure longer life, and spare parts should be kept readily available. The New York Central uses a channel-shaped cast iron casting, with rail support and fastening cast integral with it. This casting is made up in

approximately five-foot sections and fits over the top of the concrete wall for the full length of the pit, being seated in grout with the channel legs down. In the New York Central design, the legs of the channel engaging the concrete wall automatically anchor the casting on the wall, and rail chairs cast on top of and integral with the channel casting are designed to hold the bolt heads for the rail clip bolts in slots. These castings anchor the rail satisfactorily and, in addition, protect the top of the concrete wall from severe heat and disintegration.

Rail not supported on the masonry pit wall is usually supported by a wide-flange beam, using heavy rail clip fastenings. The beam supporting the rail is usually supported on high-ribbed type, heavy cast iron or cast steel castings. It is not advisable to use long spans between castings, owing to the tendency of the long and deeper girders to warp and deflect because of excessive heat. For very short spans, two track rails may be used to support the running rail by means of cast iron or steel filler blocks cast or machined to fit the inside lower flanges of the two supporting rails, with holes through the filler block to take a spreader bolt. The spreader blocks should be spaced about 18-in. centers and should be of such height that the base of the running rail is securely clamped and secured under the ball of the two supporting rails. Any joints in the running rail should be directly over a casting in order that three unbroken rail sections are available to support the live load. No adequate protection is known to be available for protecting castings, rail fastenings, etc., from excessive heat and corrosion that does not involve considerable maintenance. Rail supports and fastenings should be overly designed and spare parts kept readily available.

The Milwaukee has recently designed a 4-ft. by 4-ft. by 72-ft. reinforced concrete cinder pit having walls 12 in. thick. Rails are supported on 8-in. by 10-in. rail plates at 20-in. centers, with a cushion plate of second-hand grain belting $\frac{3}{8}$ in. thick between the concrete and the rail plate. The outside rail flange is anchored by $\frac{3}{8}$ -in. by 16-in. anchor bolts and standard rail clips. The inside of the rail plate is anchored to the concrete by two $\frac{3}{4}$ -in. by 14-in. anchor bolts at $5\frac{1}{2}$ -in. centers. Rail clips engage the inside bottom flange of the rail at 20-in. centers but are not secured by anchor bolts. A 5-in. by 4-in. by $\frac{1}{2}$ -in. continuous angle with the 4-in. leg down is placed on top of the rail clips, engaging the inside flange of the rail which is anchored in place with $\frac{3}{8}$ -in.

in. by $2\frac{1}{4}$ in. stud bolts at 20 in. centers, which anchor both the angle iron and the inside rail clips by being tapped into the rail plate. The angle iron protects the top edge of the concrete wall as well as the track fastening and rail. The space between the angle iron and the base of the rail is filled with knife-grade asbestos putty.

Care should be taken in using beams for short pit spans that are designed for bending only, as such beams with small end bearings are subject to failure of the webs over the bearings. If beams for these short spans are not designed carefully to take care of excess stress in the webs, due to the small bearing and the wheel loading and pounding of the wheels caused by the change in track construction and

to hold them in place. At the Chicago and Dayton terminals the imbedded ties are reported as remaining tight and not requiring additional anchorage. When it becomes necessary to remove a tie block, it is split into pieces, replaced with a slightly smaller one and concrete grout poured around it. When tie blocks are anchored with bolts or dowels, it is necessary to remove the rail before a block can be renewed. This feature adds materially to the cost and inconvenience in maintaining such tracks.

Turntables

Difficulty has been encountered in maintaining the heavy circle rail of three point bearing turntables. At



Spring Clips Are Used to Anchor Rails on Many Bridges

lack of cushioning, end stiffeners should be placed over the bearings.

The use of creosoted tie blocks, 8 in. by 10 in. by 2 ft. 6 in., spaced 18 in. to 20-in. centers and imbedded in concrete, is common practice in tunnels and on station tracks, wash racks and concrete roadbed, using standard track fastenings to support the rail. The Pennsylvania recently built a wash rack at its Harrisburg, Pa., engine terminal, using this type of construction. This type of rail support, using shorter blocks, is also used to some extent to support rail on engine pits.

Installations of creosoted tie blocks are particularly well suited for station tracks where cleanliness and drainage are major considerations. Such tie blocks have been in service for many years in terminals in Chicago, New York and Indianapolis, Ind., and have more recently been installed in the Dayton, Ohio, station. Drainage can be either to the center of the track, as at most terminals and tunnels, or to the side, as on the Pennsylvania wash rack. On the latter, the tie blocks are bolted down with two $3\frac{1}{4}$ -in. bolts, while on the station tracks at Dayton, and other installations, tie blocks are not bolted down, depending upon the concrete encasement

such locations the concrete under the circle rail must be the best obtainable and it should be leveled perfectly and have a solid foundation with good drainage of the top concrete surface as well as of the foundation, unless set on rock or piling; otherwise, the circle rail will not perform satisfactorily, regardless of rail or fastenings.

One railroad reports both center-bearing and circle-wall foundations resting on solid clay without adequate drainage being installed. The surrounding water level, being somewhat higher than the turntable foundations, softened the clay foundation material sufficiently to start the masonry pumping water, carrying some clay away from the foundations when the load was applied to the turntable. It was necessary to pump grout under the foundations to push out the mud and water and seal any voids, and then to install adequate drainage. Heat is sometimes used to remove snow and ice quickly from the pit, which tends to hasten disintegration of the concrete.

At the Pennsylvania's terminal at Harrisburg, the circle rail for the 125-ft. turntable is supported on cast steel chairs 10 $\frac{1}{2}$ in. high, spaced quite close together, and the concrete was finished to exact elevation. To

obtain an accurate bearing for such a location, it is usually necessary to set the screed strips about $\frac{1}{8}$ in. high and then grind down the concrete to the required elevation. Accuracy to 1/32 in. should be required. The flat concrete surface should be surface waterproofed and should pitch sharply away from the bearings to assure good drainage, and the rail supports should be such that water, dirt, cinders, etc., will not collect against the rail supports. The Pennsylvania's design at Harrisburg has a trough in the concrete outside the circle rail, adjacent to the pit wall, to collect this drainage. Good drainage could be obtained by providing a good slope to the concrete back of the circle rail, with sufficient openings between the supports for drainage to pass through. The cast steel chair rail support above mentioned is a change from the usual support of the circle rail and may prove to be a step in the right direction. It has proved satisfactory since its installation in 1938. They have the advantage that when the concrete supporting them requires repair, such repairs can be made more readily than if the rail is supported on large flat bearing plates.

The pit rail for a 115-ft. New York Central turntable installed at Toledo, Ohio, in 1941, is supported on 14-in. by 1 $\frac{1}{4}$ -in. by 16-in. steel plates with 16-in. by 1 $\frac{1}{4}$ -in. by 20-in. plates at the rail joints. The circle rail is of 130-lb. RE section and the bearing plates are spaced at 2-ft. 4 $\frac{1}{4}$ -in. centers. Anchor bolts are 1 $\frac{1}{4}$ -in. by 19 in., securing special heavy malleable iron rail clamps 1 $\frac{1}{8}$ in. thick at the heel and 1-1/16 in. thick at the toe.

Note should also be taken that the Canadian National uses its type of rail chair to support the circle rail on its turntables and finds it to be entirely satisfactory. Here again the flexibility of this type of rail support adds to its value.

Fastening Circle Rails

Extreme accuracy is required in the setting of anchor bolts for turntable circle rails and allowance must be made for the expansion and contraction of the rail. There is the possibility that, with proper setting of the anchors to take care of expansion and contraction, the circle rail could be welded at the joints, resulting in smoother operation of the turntable. However, no member of this committee has any record of such welding and, to date at least, one experienced manufacturer of turntables advises against it. The American Bridge Company takes care of lateral adjustment of the circle rail by using eccentric

adjustable lock rail clips. At the New York Central turntable at Toledo, Ohio, this adjustment is taken care of by steel wedges.

On a 102-ft. turntable, built in 1936, a 175-lb. crane rail was used for the circle rail, supported on 15-in. by 1-in. by 4-ft. 7-in. closely-spaced bearing plates, each having four 1½-in. by 21-in. anchor bolts with adjustable lock rail clips. It is believed that shorter bearing plates or rail chairs, properly spaced, are preferable to these large bearing plates, as it is difficult to get an even bearing under large plates and they tend to block the drainage back of the circle rail. Also, any repairs required to concrete under the bearing are difficult to detect and repair.

All of the railroads contacted use on their turntables ties similar to those used on open-deck bridges. A few railroads report satisfactory welding of rail joints on turntables to give smoother riding, and a few use special proprietary fastenings to prevent shifting of the rail. To prevent pounding at the ends of the table, some place hardwood ties or wider ties for four ties at each end. The usual practice for supporting the ends of rails on the pit wall is by means of a heavy wide-flanged steel circle beam anchored on top of the pit wall, to which track rails are secured with two-bolt rail clips. These rails should not be connected directly to the pit girder by bolting or welding as the expansion of the rail on the approaches will either break the connection or shift the rim girder. A liberal installation of anti-creepers is necessary on the approach tracks to reduce creeping of rail to a minimum.

Rubber tie plate shims have been developed by rubber manufacturers for the circle rail and for the running rail on turntables. This is one of the newer developments that would seem to have much merit.

At least two railroads report the use of angle bars at the ends of rails to help retard damage from pounding. Several railroads report that no special precautions are taken to eliminate pounding at the ends of the turntable, except to attempt to maintain a ½-in. gap and level surface of the rail ends.

When timber ties are used on the turntable and the approach rails rest on masonry or on a wide-flanged beam on the masonry, it would be good design to support the ends of the rail on the turntable on two steel I-beam ties, using some rigid-type rail fastening to secure the rail to these steel beams. Two-bolt sturdy rail clips should prove satisfactory for anchoring rails to the pit rim girder.

Tracks approaching a turntable

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should be tangent well beyond the length of the longest locomotive and tender, otherwise trouble will be experienced in operating the table.

Anchoring Rail on Bridges To Resist Longitudinal Motion

In considering the longitudinal motion of rails on bridges due to contraction and expansion and creeping, the most important consideration is to retard the rails on the approaches from exerting movement on the bridge. This can best be accomplished by bunching rail anchors on the embankment.

In replies to our questionnaire, we find that the railroads differ on this subject. The Canadian Pacific, Pennsylvania, New York Central, Great Northern, Baltimore & Ohio, Chesapeake & Ohio, and Chicago, Milwaukee, St. Paul & Pacific do not anchor rail on bridges. The Michigan Central uses special anchors. The Rock Island places special expansion devices on exceedingly long fixed spans. The Northern Pacific anchors at the fixed ends of spans and bunches the anchors on the roadbed adjacent to the bridge. The Illinois Central reports the use of both switch points and expansion joints. The Southern Pacific reports one bridge, 4,460 ft. long, on which the rail is laid continuous. However, on ordinary spans over 400 ft. long, this road provides expansion rails because of the concentration of the expansion at one end. The Elgin, Joliet & Eastern installs expansion joints at each end of long structures. The Chicago & North Western provides switch points at the expansion ends of long spans; for shorter spans it finds compression fastenings very effective.

Conclusions

The fastenings on bridges, pits and turntables are, to a large extent, designed to conform to, or are an adaptation of, the general track structure. Where headroom and other requirements allow, ballast-deck structures are in favor, owing to the fact that such decks provide a continuity of the ballast section, permitting track forces to take care of gage, line and surface.

Where ballast deck construction cannot be recommended, due to one or more of the many governing limitations, rail may be fastened directly to the steel or concrete deck by means of heavy malleable iron rail plates and clips. In case rails are anchored directly to concrete, careful consideration should be given to obtaining the best concrete available, suitably waterproofed, in order that the life of

the fastening will not be limited by the life of the concrete.

For open-deck steel and timber structures, the preframed and prebored time-tested creosoted timber tie and standard track fastening are still in universal use to anchor the rail to the structure. Ties of quality, even when preframed, prebored and treated, have tendencies of weakness. They are subject to checking and splitting, fire damage and damage due to derailment. However, no suitable substitute has been developed to date.

Consideration should be given to the welding of rail joints on open-deck bridges to give smoother riding track, reducing impact. Also, for special installations, a tie plate having a rubber bearing for the rail is worthy of study for the same reason.

Many special types of rail fastenings are in use on pits. Substantial steel bearing plates at 18-in. to 20-in. centers, with heavy steel or malleable iron rail clips and ¾-in. or 1-in. anchor bolts will prove satisfactory. On cinder pits, fastenings should be protected from excess heat and rust action.

Creosoted tie blocks encased in concrete, using standard tie plates and track spike fastenings, are used extensively in tunnels, wash racks, station tracks and, to some extent, on concrete pit walls.

One suitable design for fastening rails to all structures is a goal well worth striving for, providing such a design meets economical necessities. Your committee did not reach this goal, but trust that the search it has made will assist others in quest of it.

Committee—J. S. Hancock (chairman), br. engr., D. T. & I., Dearborn, Mich.; G. S. Crites (vice-chairman), div. engr., B. & O., Punxsutawney, Pa.; H. B. Christensen, div. engr., C. M. & St. P. & P., Savannah, Ill.; J. J. Clutz, Lt. Col., 730th Engineer Battalion, Railway Operating, Ft. Wayne, Ind.; H. M. Harlow, asst. supv., b. & b., C. & O., Clifton Forge, Va.; H. W. Hauerslav, ch. dftsmn., C. M. St. P. & P., Chicago; J. E. Hogan, asst. div. engr., C. & O., Hinton, W. Va.; R. W. Johnson, asst. engr., C. M. St. P. & P., Chicago; W. J. Lacy, supv., b. & b., M. P., Jefferson City, Mo.; H. C. Madson, designer, C. & N. W., Chicago; F. H. Masters, ch. engr., E. J. & E., Joliet, Ill.; A. A. Sirec, engr. dftsmn., C. & N. W., Chicago; E. E. R. Tratman, civ. engr., Wheaton, Ill.; and B. M. Whitehouse, gen. br. insp., C. & N. W., Chicago.

Discussion

H. M. Church (C. & O.) explained that the construction on the Chesapeake & Ohio, which was mentioned in the report, is not standard, but is experimental. R. E. Caudle (M.P.) recommended that in making a partial renewal of ties on open-deck

bridges, the new and old ties be segregated, that is, that a certain number of ties be renewed out of face, and that any usable ties recovered be used to spot in on that portion of the bridge where the old ties remain. Mr. Caudle said that it is the practice on his road not to anchor rail on open-deck bridges, and cited cases where conditions would be quite undesirable because opposite rails run in opposite directions.

G. S. Crites (B. & O.) commended the practice of keeping new and old ties on bridges segregated, saying that he knew of cases where new ties that had been spotted in were crushed or otherwise broken because they were required to carry a disproportionate part of the load, since the old ties are rarely full section.

An extended discussion concerning

turntables arose when A. Chinn (Alton) recommended wood supports for the track rails on turntable circle walls. In this connection, A. M. Knowles (Erie) said that the A.R.E.A. had concluded that a wood cushion is preferable, provided it is protected with heavy plates under the rails, for both this cushion and the turntable ties receive heavy blows as the locomotive wheels pass to and from the table. Mr. Church reported that where I-beams have been employed to support the track rails they have given continuous trouble, and that he strongly favored the wood cushion. On the other hand, Mr. Crites believed that I-beam supports are satisfactory for use with turntables having three-point support, but would use a wood cushion with center-bearing tables. Mr. Knowles

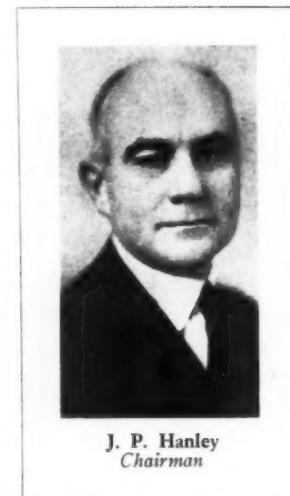
stated that in his experience the three-point tables give the most trouble with the I-beam support, and this was confirmed by Mr. Church. A. L. McCloy (P.M.) said that he had overcome the abuse of the wood cushion by inserting 1-in. plates, 16 in. long, under each rail on the turntable wall. However, he had experienced more trouble with the end ties on the turntable and had placed similar plates, wide enough to cover two ties, at the ends of the turntable, with excellent results. He also added an inside guard rail, with fillers, bolted to each running rail, to aid in cushioning the shock as the wheels come on the turntable. Mr. Knowles reported that he had done very much the same thing, except that his plates were two feet wide and he used an easer rail instead of a guard rail, with satisfactory results.

Meeting the Demands for Increased Water Supplies in Fast Freight Service

Report of Committee

ONE OF the outstanding trends in railway operation has been the increasingly fast schedules of freight trains during the last three or four years. Gone are the days when the heavy slow-moving "drag" was considered the pride of each division superintendent and cars were held back until full tonnage could be assembled before starting trains from initial terminals. This does not mean that tonnage is now neglected, but rather that certain freight trains have been placed on timetable schedules like passenger trains and on such trains tonnage is limited by the running time and speed which are definitely maintained. In a recent article in the public press, J. J. Pelley, President of the Association of American Railroads, stated that the railways moved 470 billion gross ton-miles of freight in 1941, or 5.1 per cent more than in the previous high year of 1929. Last year the railways hauled more freight per train than ever before and moved each train over the road nearly one and one-half times as fast as 20 years ago. Freight car capacity averaged 50.4 tons, or 18.6 per cent more than in 1921. Tractive effort of locomotives averaged 51,495 lb., or 39.4 per cent more than in 1921.

In order to maintain the schedules necessary to accomplish the results mentioned, certain changes have been made in servicing the locomotives handling these trains, such as servicing them at division points without



J. P. Hanley
Chairman

detaching them from trains, which practice, in turn, requires quick watering, coaling, fire cleaning and other train service work.

Previous Reports Valuable

This report will consider the water facilities required, and should be considered in connection with two previous reports submitted to the association. In 1937 a committee, of which Mr. H. B. Christiansen was chairman, presented a report on Meeting Today's Demands for Water Service,

and in 1940 a committee under the chairmanship of Mr. W. G. Powrie, presented a report on The Adjustment of Locomotive Watering Facilities to Larger Tenders and Higher Speed Trains. The Water Service committee of the A.R.E.A. also presented a valuable report to that association in March, 1941, on The Practicable Size of Water Columns and Supply Lines for Maximum Delivery of Water to Locomotive Tenders. This latter report points out that the adequate delivery of water generally depends on: (a) The size, length and condition of the supply pipe; (b) the flow head above the water column outlet; and (c) the size and design of water column. All of these reports present useful information and should be studied carefully by members of this association preparatory to attacking a condition that has now become very urgent on many railroads.

Increased Demands

The fast freight locomotive now requires a larger volume of water at increased flow rates at locations often designed for much less severe operating conditions. The practice has resulted in placing unusual demands on terminal and key stations and decreasing demands at other points. In order to show the methods used, the committee presents a summary of the replies received from a few roads representative of different parts of

the country and showing somewhat different methods of handling the water supply problems.

Railway "A"

About the same time that freight trains were speeded up, fast passenger runs were also inaugurated, and although this report refers to freight service, the increased demand for water for passenger trains also enters into the picture. In many cases the improvement of water stations was made principally for the passenger service, but also benefits freight trains.

As freight and passenger schedules were speeded up, one of the features contributing to maintaining the schedules was the reduced time consumed in taking water and coal and servicing the locomotives en route. It was found that many minutes could be saved if water would be delivered into the tenders faster, or coal and water could be taken at one stop, which would also include inspection and ashpan work. As studies were made, it was found that in a few instances improvement could be made at a small cost, but that in most cases it was necessary to spend considerable money to make the desired improvements.

When the railways were constructed originally, water stations were located where water was obtained most easily, regardless of the quality of the water or the grade and alignment of the tracks. At that time information on underground water sources was not available. It is now the policy of this railway, as water facilities require renewal or become inadequate, to relocate them at the proper places from an operating standpoint. Wells are drilled if necessary, where underground water is satisfactory. Where underground water is not available or not suitable for boiler use, storage reservoirs are provided to impound surface water or water is taken from a stream that has a dependable flow. By this procedure, the number of active water stations has been reduced.

While we do not need intermediate water stations for fast trains, we have local service, industry switching, interchange points, junction points and work-train service for which these stations are necessary. Furthermore, the main water stations are shut down at times for repairs and the intermediate stations are then used. The conditions, however, have forced the concentration of maintenance on the main stations with good results.

It has been the practice on this railway to use electric power for operating pumping plants wherever de-

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pendable current is available. For surface supply, centrifugal pumps are used, while for deep wells, turbine pumps are used.

To increase the flow of water to locomotives where fast trains are watered, improvements have been made at some places by eliminating

the expense cannot be justified.

In planning future water station improvements, it is well to take a long-range view and study the effect that Diesel locomotives will have on water demands.

The faster train service and increased demand have placed a greater

This Large Freight Locomotive Takes Water on the Main Line in Four to Five Minutes



bottle necks in pipe lines, such as installing wyes in place of tees, eliminating restricted places in pipes and cleaning pipes where the size is reduced by incrustation, and in some cases by installing a larger water column. At some points it has been necessary to raise the storage tank, install a larger tank or increase the size of the pipe serving the water column.

Improvements of this kind usually secure a flow into the tender of 4,500 to 5,000 gal. per minute. One installation delivers 5,000 gal. per min. and has demonstrated that a large flow can be taken from a water column without hazard to the man taking water. Where water is taken direct from a tank through a sway-spout, the present type of valve and spout limits the delivery to about 3,000 gal. per min. Perhaps a valve and spout can be designed to secure a better flow for sway-spout installations.

With the faster freight service, a greater demand for water has been created at the main and halfway points. This has necessitated larger storage tanks, larger pump equipment, and, in a few cases, increased sources of supply. Correspondingly, the demand at the intermediate points has decreased.

At several points on this railway, water columns and cinder pits have been located so that the ash pan is cleaned and coal and water taken with one stop. This is a desirable arrangement at all main points where fast freight engines are serviced, but in some cases this is not feasible on account of the track layout, or where

responsibility on the water service department. Materials are not now available for desired improvements, and this may also affect materials for repairs to existing facilities. These conditions provide a test of the ingenuity and resourcefulness of the water service forces in maintaining the water supply facilities in first-class shape.

Railway "B"

The territory on this road referred to in the following is a double-track main line on a route of heavy transcontinental fruit and meat traffic, as well as general freight traffic. The distance between terminals is 124 miles. There are three scheduled time-freights westward and seven eastward each day, and the fastest scheduled time between these terminals is four hours for eastward trains and four hours and twenty-five minutes for the westward run. There are also, of course, such extra trains as the traffic requires. The fleeting of trains has been the practice for many years.

The locomotives hauling these trains have 275-lb. steam pressure, and are equipped with stokers, feedwater heaters and boosters. Their tractive power is 71,400 lb. Tender capacity is 18,000 gal. of water and 25 tons of coal. Three water stations have been closed since these large locomotives were placed in operation.

No attempt has been made to arrange water and fuel supplies to provide one-stop service. It is thought that falling coal might interfere with handling the water spout and that coal particles might get into the water.

The plan is to deliver 3,000 to 4,000 gal. per min. at water stations, which fills the large tenders in four to five minutes and is satisfactory without attempting to secure the additional saving in time that might be made by combining facilities.

In 1928, when one of the large terminals on the road was completed, a reservoir was built for the purpose of storing and reclaiming surface drainage and waste water from the enginehouse and auxiliary facilities to supplement the supply of water then obtained from deep wells. In 1926, a pipe line was installed along the right-of-way to carry city water to the terminal. This pipe line discharges into the reservoir above mentioned. Water is drawn from the reservoir through a treating plant and thence to pipe lines and water columns by centrifugal pumps. This terminal has a peak hourly demand of 250,000 gal.

At the opposite end of the division the source of supply is a large river where the water is treated in a plant on the river bank and transferred to the shops and enginehouse by centrifugal pumps. At other water stations the source is underground, as there are no satisfactory surface supplies.

Railway "C" Oil Burning Locomotives

Seventy per cent of the company-produced locomotive water is pumped from deep wells on this railway. Many of the wells and deep well pumps, with their 50,000 to 75,000-gal. capacity roadside tanks, do not furnish enough water to meet the peak demand of a fleet of 4 to 8 trains requiring water within a period of 2 to 4 hours. The peak demand has been met at several stations by installing surface pools of from 50,000 to 100,000 gal. capacity, and installing horizontal pumps of large capacity to elevate the water from these reservoirs into tanks. At these points, the deep well pumps discharge into the tank until it is filled, and then pump into the surface reservoir, thereby storing water to be elevated into the tank by the larger capacity horizontal pump as soon as the water in the tank is lowered to the required point. These installations are operated by automatic control.

Where steel tanks are available, the capacity has been increased sufficiently to meet the demands of fleets of trains by riveting or welding rings to their tops. Where wood tanks exist and it is not satisfactory to install surface reservoirs, an additional tank is installed.

Standby connections are often installed with municipal and private water works. The connections are

provided with float valves so the water will flow when the water in the tank is lowered to some fixed point, thereby augmenting the delivery into the tank in time of heavy demand during short periods of time. Where it is not too expensive, another well and pump are installed to serve the purpose of a standby and are automatically controlled to cut in and increase the delivery when fleets of trains lower the water in the tank.

Number of Stations Reduced

This railway has 106 water stations on 3,000 miles of line; 38 of these stations have water treating equipment in operation. Ten years ago there were 140 water stations. The stations are operated by 12 regular and 20 part-time pumbers. Larger tenders and auxiliary tanks on locomotives, plus automatic operation of plants, permitted the reduction in the number of stations.

Larger engine tenders and auxiliary tanks attached thereto have made a saving in the water service department alone of \$25,000 annually, mainly by eliminating intermediate water stations. Large engine tenders and auxiliary tanks made a much greater saving in money, as well as in time by reducing the number of train stops for water. A 24 per cent reduction in the number of water stations means a corresponding reduction in the number of train stops for water. Therefore, the saving in train operating costs, considering time that was lost, added wear on equipment and extra fuel, and miscellaneous items, amount to a considerable sum annually.

Since the attack on Pearl Harbor it has become the duty of the American railways to render the greatest possible service to our country in defending its borders against armed aggression. The railways were generally in an excellent state of preparation to undertake the efficient handling of the greatly increased tonnage. Power and equipment had been conditioned for service, and locomotive water and fuel facilities were in good condition to meet the demand.

Demand May Continue

It is probable that the demand will continue to increase for the next few years. After the war, any decrease in the transportation of war materials may be off-set by the peace-time requirements. It is reasonable to assume that it will be the problem of the United States to furnish food supplies for the peoples of a large portion of the world whose stocks will have been exhausted during the conflict; also to furnish essential materials and ma-

chinery for their economic rehabilitation. Therefore, the railway water service personnel should have plans to meet this increased water demand.

While this railway does not have a continuous density of traffic and a large number of trains, it is subjected to "fleets" or multiple sections of trains operating from a half hour to an hour apart, which results in heavy withdrawals from water tanks in short periods. In the Southwest, it is the opinion that demands on the railroads are going to increase considerably in the next few years, and arrangements are being made to meet these increased demands by installing temporary water stations at "third points" where water is now being taken at "half way" points and at "quarter points" on districts where large engine tenders are used. Temporary stations are also being installed convenient to yards where considerable switching is done to serve the larger industries and army camps. Each individual water station should be watched closely and prompt measures taken to augment the supply if a shortage of water is indicated. The following methods are suggested for improving the water flow to tenders where necessary:

- (1)—Raise the tanks that supply the water column
- (2)—Lay an additional pipe line from the tank to the column or install a larger column

(3)—In the event that the tank is located too far from the column, move the tank to a location near the column or install a second tank near the column

(4)—The installation of large-capacity booster pumps in the supply line between the tank and the column is not recommended. In the event of failure of the pump, the flow of water is obstructed.

Railway "D"

The largest tenders on this railway have a capacity of 15,000 gal. of water, and fast freight trains often operate from one terminal to the next without a water stop. Auxiliary tenders are also used. These tenders contain 12,000 gal. of water and are coupled behind the regular tenders of 11,000 gal. capacity. This combination then has a total capacity of 23,000 gal. Such combinations also enable fast freight trains to operate over an engine district without a water stop.

The use of the auxiliary tenders was developed because the locomotives were originally secured with 10,000-, 11,000- and 12,000-gal. capacity tenders, which were inadequate for non-stop use. When the large single tenders and combinations are used on semi-fast freight trains, these trains make one intermediate stop for water between terminals. The manholes

in the auxiliary tenders are spaced so that it is possible to fill both tenders with one "spotting" of the locomotive. Efforts are being made where new coaling stations are erected, to space the coal filling and water filling equipment such that both coal and water can be delivered without re-spotting the engine. This condition is also planned where cinder pit facilities exist for servicing the engine on the main line without detaching it from the train.

The use of large-capacity tenders has placed an unusually heavy demand on the terminal and key stations and has permitted the retirement of many of the intermediate stations. However, all freight trains cannot go as far for water as the manifest runs, so it is necessary to maintain many intermediate stations for a small demand. The heavy tonnage trains and the local freight trains still require rather close spacing of water stations.

This railway is using automatic electric pumps at many stations where steam equipment was formerly used, and has recently installed an automatically-controlled Diesel engine for pumping water. This engine is started by means of the usual electric starting motor, which, in turn, is actuated by a float switch on the tank. The engine is equipped with a generator and a dual set of batteries to supply the starting current, as commercial current is not available.

Numerous complaints have been received relative to the length of flow time required to fill the large tenders through existing water columns and water column mains, and this condition will probably warrant the use of 14 or 16-in. diameter mains in future installations, instead of the present 12-in. mains, depending on their distance from the tank. It is believed that larger mains are preferred to higher tank towers, and that 12-in. water columns are large enough when supplied by mains of adequate size.

Other Information

Information submitted by committee members showing conditions on their respective railways has been summarized as follows:

The maximum number of locomotives taking water at the heaviest water stations is 20 to 94.

The water capacity of locomotive tenders is 9,000 to 22,500 gal., and the capacity of auxiliary tenders, where used, is 12,000 gal.

The coal capacity of tenders is 20 to 26 tons, and the oil capacity, where this fuel is used, is 11,660 gal.

The means usually taken to improve water column flow is: (a) clean pipe and eliminate restricted sections;

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(b) raise water tanks; (c) install larger supply pipes; (d) install additional supply pipe and connect them to the existing main.

One railway using oil as fuel reports the use of 11,660 gal. of oil as compared with 161,000 gal. of water per 1,000 locomotive miles, or a ratio of 1 gal. of fuel to 13.8 gal. of water used.

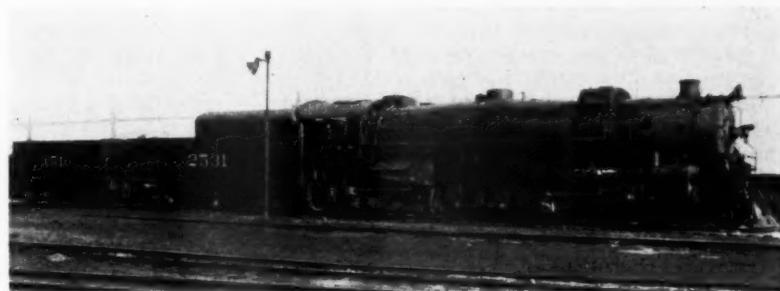
The time required to fill the larger tenders is 5 to 12 min.

Fast freight trains usually go 80 to 125 miles between stops for water,

sizes and flow head for this condition installed.

(4) In new construction, the use of 14-in. and 16-in. water column mains should be considered instead of the 10-in. and 12-in. sizes formerly used. However, the flow head tables, after deducting friction losses, will indicate the correct size for 4,000 to 5,000 gal. per min. as now required.

(5) The use of increased roadside storage at key and terminal stations, or increased inlet flow into existing storage, is often required to supply large



Larger Engine Tenders and Auxiliary Water Tanks Have Eliminated the Need for Stops at Many Intermediate Water Stations

from 80 to 160 miles for coal, and 250 miles for oil.

The use of large tenders has generally lightened water station maintenance by concentrating the work on key stations and permitting the closing or reducing the maintenance on intermediate stations.

The "one stop" principle is generally preferred for taking fuel and water where facilities can be arranged without excessive cost.

The use of larger tenders has indicated that increased roadside storage, surface reservoirs or increased flow into existing storage, are often, but not always required.

The unit coal consumption in fast freight service is 70.5 lb. per 1,000 gross ton-miles, and 265 lb. per engine mile, while the unit water consumption in such service is 55 gal. per 1,000 gross ton-miles, and 160 to 205 gal. per engine mile.

Conclusions

(1) The use of locomotive tenders with a capacity of 20,000 to 25,000 gal. is pronounced at the present time and it appears that this practice will be extended.

(2) The water flow and capacity to supply larger tenders promptly are inadequate at some stations, and plans should be made to correct existing conditions and to prevent their recurrence in future installations.

(3) A flow of 4,000 to 5,000 gal. per min. should be provided in new or remodeled installations, and pipe

tenders during peak periods. The increase in storage may sometimes be secured by relocating tanks retired at intermediate stations.

(6) The demand at intermediate stations has increased but these stations cannot always be eliminated as they are required for local trains, switchers, junctions and industrial tracks.

(7) The use of surface reservoirs near roadside tanks and connected to them with a large capacity booster pump may be suitable in some locations to replenish quickly the water taken from the roadside tank by "fleeted" trains.

(8) The use of an additional pipe line to increase the supply to water columns is generally preferred to installing a much larger single main to secure the capacity and then salvaging the older main. This method is sometimes referred to as a "loop" system.

Committee—J. P. Hanley (chairman), w. s. insp., I. C., Chicago; R. E. Caudle (vice-chairman), asst. engr., strs., M. P., Houston, Tex.; A. E. Bechtelheimer, br. engr., C. & N. W., Chicago; W. D. Bird, gen. for., b. & b., A. T. S. F., Albuquerque, N. M.; L. A. Cowser, w. insp., B. & O., Dayton, Ohio; H. C. Crawford, gen. for., b. & b., S. P., Dunsmuir, Cal.; V. E. Engman, ch. carp., C. M. St. P. & P., Savanna, Ill.; W. A. Hutcheson, supv. b. & b., C. & O., Clifton Forge, Va.; F. M. Lehrman, br. dftsmen., C. & N. W., Chicago; C. A. J. Richards, mast. carp., Penna., Grand Rapids, Mich.; H. T. Rights, br. engr., retired, L. V. Bethlehem, Pa.; D. C. Shaddock, for. w. s., N. Y. C., Corning, N. Y.; J. L. Varker, supv., b. & b., D. & H., Carbondale, Pa.; M. P. Walden, asst.

supv., b. & b., L. & N., Evansville, Ind.; and K. J. Weir, special water service inspector, C. M. St. P. & P., Chicago.

Discussion

President Dove called attention to the mention of an automatic pumping station powered with a Diesel engine, and asked if the trend was not more definitely toward electrically-operated pumping stations. Chairman Hanley replied that under present regulations permission must be secured from the W.P.B. to extend an electric power line more than 500 ft., and that electric motors are very hard to get at the present time. He added that this is true also of Diesel engines and suggested that, in view of this situation, the very best care must be given to the water service equipment we have.

Chairman Hanley explained that

the problem of increasing the water delivery rate is usually not one of storage, but rather of increasing the rate of delivery from the existing storage. This can be accomplished by installing an additional pipe line between the tank and the crane or by raising the tank, he said.

A. B. Pierce (Sou.) mentioned that the W.P.B. refused their request for electric motors for the last two water station installations on the Southern and suggested that they get second-hand motors, which are also almost impossible to obtain. He added that if you can secure secondhand motors, you can probably get a good priority rating on the other materials needed. The Southern, he said, has been fairly successful in getting wood tanks recently, since they already had secondhand hoops and priority ratings

were obtained for the other materials.

E. M. Grime (N.P.) said that the Northern Pacific had found many places where it was necessary to increase the flow of water at the columns, and suggested, assuming that the volume of water supply is ample, moving the tank closer to the delivery point or installing a larger pipe line between the tank and the water column. If the supply is not ample, he said, then you have a big job, more or less out of the question today, which may require larger storage or bigger pumps, or both.

A. G. Dorland (E. J. & E.) suggested that separate water facilities need not be maintained by two or more roads at junction points, and stated that his road had removed several installations at such points and now uses facilities of other railroads.

Wearing Surfaces for Building Floors, Platforms and Roadways

Report of Committee

THE importance of wearing surfaces in the operation and maintenance of railroads is most apparent when thought is given to the fact that it is on these surfaces in station buildings, platforms and roadways that the public comes in contact with the railroad. Likewise, it is in the offices, freight houses, shop buildings and engine houses that the wearing surfaces of floors are ever before the employee. All in all, it can be said that the wearing surface is the common ground on which all of the human element involved in the operation and support of the railroad has its meeting.

The proper maintenance and construction of these wearing surfaces in the various facilities of a railroad constitute a major item in the bridge and building department's responsibilities. Each installation of a wearing surface must satisfy certain requisites established by the particular type of traffic, as well as the age-old limitation of cost. Safety is a factor which should always be given careful consideration in any wearing surface, whether to prevent injuries to patrons or to employees.

It is therefore logical to state that each installation of a wearing surface shall be given special attention and a careful study be made to determine the best type of material to meet the particular requirements.

Wood is probably the oldest generally-used material in surfacing im-



T. H. Strate
Chairman

portant railway platforms, consisting of plank and end grain block. Concrete, mastic-coated concrete, asphalt and brick are also used. The floors most widely used are of wood-composition, tile or terrazzo.

Freight house floors are predominantly of wood-plank on a frame substructure. Some floors are of concrete on earth fill or concrete on a reinforced substructure. Shop and engine house floors are generally of either wood block or concrete.

Shop driveways, team track driveways and pedestrian walks are

chiefly of concrete, with some brick.

Among all of these major types will be found the common fill platforms and walks, consisting of either cinder or screening top.

Requirements for Wearing Surfaces

(1) Important passenger stations.

In such structures the floor surface must be highly resistant to the abrasive action of heavy pedestrian traffic. It must have a surface texture which will not be slippery when either wet or dry; yet the texture of the surface must permit easy cleaning. The material must be water repellent. The wearing surface shall be on a base which provides some resiliency for walking ease of the patrons. The surface shall be of a pleasing or neutral color that reflects, rather than absorbs, light. The presence of sound-absorbing qualities in the surfacing would be advantageous.

(2) Second class passenger and freight stations.

Because of the nature and volume of the traffic imposed upon the wearing surface, abrasive resistance is of minor importance in structures of this type; resilience and sound deadening do not warrant consideration. However, since janitor service is rarely provided at this type of station, and the agent-operator is usually also the janitor, ease of cleaning and a non-slip surface

should be stressed. Light-reflecting properties should also be considered for this type of station is seldom adequately lighted.

(3) Offices.

Sound absorbing qualities are of prime importance in office floors, and resiliency is of only slightly less importance. The floor must be of such hardness as to enable it to withstand heavy concentrated loading without being indented. It should also have a dull finish capable of reflecting light without glare, and must, of course, be easy to clean.

(4) Important freight stations, including warehouses and piers.

Smoothness is probably of most importance in floors of this classification, because of its effect on both handling costs and damaged freight claims. Of equal importance is the hardness of the wearing surface and its resistance to concentrated wheel loads. Rigidity of the surface, instead of resiliency, must be provided here for ease in operating wheel trucks.

Another very important characteristic for this type floor is imperviousness to moisture. Its absorbent qualities must be nil. It must be odorless and should have no properties that will stain shipments; it should not be able to impart a taste to merchandise, especially food stuffs. It should be as nearly dust-proof as possible and lend itself to quick and economical repair. Its substructure should be permanent and of sufficient strength to withstand very heavy loadings, as loads in excess of 300-lb. per sq. ft. are not unusual on such floors.

(5) Shops and engine houses.

In buildings of this type the floor must be impervious to oils and greases as well as to hot and cold water. It must be able to withstand shock from the impact of falling objects. It should offer some resiliency to the workmen, especially in machine shops. It must be such texture that when coated with oils, greases and water it does not become slick and it should be easily swept or cleaned. It must be of such strength that it can withstand heavy concentrated loads such as are imposed by jacks.

(6) Pedestrian walks, loading and trucking platforms.

As most facilities under this classification are open and exposed, the first consideration in their construction should be their resistance to the elements. Another important characteristic should be their ability to free themselves of surface water quickly. They, like all other wearing surfaces, must be hard and resistant to abrasive wear and to wheel

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wear under heavy loadings. Those located in colder climates must be resistant to ice-melting chemicals and thawing agents.

(7) Roadways for terminals, team tracks and station roadways.

Wearing surfaces here are of less importance than their supporting structure, as most modern traffic over these surfaces is vehicular on rubber tires; however, their surface drainage is of vital importance and must be adequate to enable them to



Floors at Important Freight Stations Must Be Smooth and Wear Well Under Heavy Trucking

drain free of water quickly under nearly cloudburst conditions. In general, they should be of the same construction as adjoining streets.

Wood Plank and Block Floors

Wood plank flooring is still the wearing surface material of lowest original cost. However, the cost of maintenance may be high although this factor will not be discussed in this report, because of the numerous use conditions which affect such figures.

Where planking is laid on a wood joist supporting structure, it is recommended that the joists be of such dimension as will provide a wide surface for nailing, the minimum width being three inches. This will insure full gripping power of the nails or spikes, by eliminating the tendency to nail through a corner of the joist. Such joists will also provide sufficient width for end butting of planking to keep the nails a sufficient distance back from the end of the plank to provide good nailing.

When plank flooring is to be laid over a concrete sub floor, the plank shall be placed on bevelled sleepers which shall be a minimum of 3 in. by 3 in. The sleepers are to be set

in the concrete, or bituminous material, at the time the sub-floor is laid.

Wood-finish floors, which are usually edge grain fir or maple, have proved very suitable for use in stations and offices and are usually laid over a one-inch wood sub flooring. This type of floor is also laid on sleepers set either in concrete or bituminous material and in all cases the fastening is by blind nailing.

Laminated types of floors of either treated or untreated materials have been used but they are expensive and in most instances their cost is not justified.

The types of fastenings for wood floors consist of common nails and spikes; cut nails, boat spikes, lag screws, drive screws and bolts. Boat spikes or double grip spikes are recommended for the fastening of plank floors and cut nails for the blind nailing of maple finish floors.

Where platforms or floors are required in tracks where frequent surfacing is necessary, a type of wood construction is desirable that can be removed in sections so that the timbers will not be damaged by pulling and redriving the spikes.

End grain wood block floors are very desirable for conditions where heavy traffic exists, if protected from the elements, as in a freight house. Such floors offer great resistance to heavy wheel loads. In this type of floor the wood blocks are laid tight and embedded in hot asphaltum pitch on a sand cushion over a concrete sub floor. Where this type of floor is exposed to the elements, water and moisture swell the blocks, and, combined with frost action, heave them out of place. It is recommended, therefore, that exterior use of this flooring shall not be made.

Concrete Floors

The use of concrete for wearing surfaces has proved highly satisfactory for all uses which require wear resistance to heavy loads as well as the elements. It is readily cleaned and therefore is found adaptable to many uses on a railroad.

Since the quality of the concrete is controlled by many factors of materials, mixing, placing and curing, this report will not attempt to discuss these factors. Most of the railroads have in their engineering departments specialists in concrete design who work with experts of the Portland Cement Association in combating specific problems.

There has been considerable discussion relative to the merits of a monolithic floor slab versus two course construction which employs a subfloor with a one-inch finish

topping. The monolithic type is the simplest and least expensive for the entire floor slab is placed at one time. For this type of floor it is necessary to use an inexpensive mix which may be difficult to finish as smoothly as may be desired. The two-course type of construction, in which a base is first laid and a topping approximately one inch thick is laid at a subsequent time, permits the use of a more expensive mix for the topping. With this method a mix can be used which is adapted especially to the type of service and a good smooth surface is easily secured. Disadvantages are the added expense of the additional operations and the danger that the topping may not become well bonded to the base slab, unless great care is taken. To overcome this last difficulty, a combination of the two types of construction is sometimes used, in which the topping is placed before the base slab has set. This requires good timing and organization of the crew laying the floor.

Where concrete has been used in engine pit construction, many problems have arisen from the use of locomotive jacks on jacking pads. The concrete in the pits has withstood the loadings placed upon it, but the surface of such jacking pads has become destroyed by the jacking operations. This problem has been combatted by placing a steel grating armor on the jacking pads.

The use of concrete for floors, walks, steps, etc., in passenger depots has long been a problem for bridge and building forces, because of the accidents which occur from patrons slipping on these surfaces. The introduction of an abrasive in these surfaces is recommended to combat this hazard. On walks and floors, the abrasive is worked into the surface with the finish troweling. For steps it is recommended that pre-cast abrasive strips $\frac{3}{8}$ in. to $\frac{1}{2}$ in. wide be set into the front part of the tread. The manufacturers of these pre-cast strips prefer to cut the grooves and place the strips after the stairs are cast and set.

Terrazzo, Magnesite, etc.

Terrazzo floors have a definite place in important passenger stations where their cost can be justified. These floors have excellent wearing qualities, are not slippery, are easily cleaned and offer unlimited possibilities in design and use of color to harmonize with the interior scheme.

The floor commonly known as magnesite, which is a magnesium oxychloride composition, has a wide use in the surfacing of existing wood floors. A $\frac{1}{2}$ -in. layer of this mate-

rial is laid and troweled to a smooth hard finish, which is impervious to moisture and does not burn. The material can be carried up on the walls to form a cove base and is therefore worthy of consideration for use in locker rooms, etc., which necessitate a floor which can be cleaned easily and thoroughly. Magnesite floors have been found to become slippery when wet and are not recommended for toilet rooms.

There are many composition surfacing materials such as rubber, cork and asphalt tiles, linoleums, etc. These materials are not designed for long life in places of heavy traffic. However, they have an important field on the railroads in that they provide an attractive floor for second class passenger stations and offices. They give a resilient, sound-absorbing surface which is desirable for this type of service. They do not offer a great deal of resistance to abrasion, are easily indented by concentrated loads and therefore consideration must be given to the use to which they will be subjected.

A very complete and thorough analysis of the wear resistance of all of these materials is made in report B.M.S. 80, Building Materials and Structures, published by the National Bureau of Standards, Washington, D.C.

Platforms and Curbings

At stations of minor importance which have light traffic, an economical surfacing for platforms and roadways may be constructed of bituminous material. This material may be either premixed or mixed in place and hand-tamped or rolled with heavy rollers to a hard compacted surface. The result is a surface which is resilient, does not get slippery when wet and holds up very well under wheel loads, particularly solid or pneumatic rubber tired wheels. These materials lend themselves to the repair of any bad spots which may develop, as the new material in a patch readily bonds into the existing platform surfacing.

Brick as a paving material has many years of service to prove that it has excellent qualities for use in walks, platforms and team tracks. However, the success of this type of paving depends upon the base on which it is laid. A concrete subfloor is by far the most satisfactory. As a binder, both asphaltum and cement grout are used, asphaltum being preferable for driveways and cement grout for walks and station platforms. Paving brick is very resistant to salt and chemicals used to melt ice and snow on platforms,

which is one reason for the continued use of this material.

The curbing becomes a very important part of each paving project in which brick, screenings and bituminous products are used. The curbing serves to hold the material in place at the edges of the platform or walk, as well as to give a straight and finished line, from the standpoint of appearance. Timber and precast concrete curbs are the most widely used for railroad purposes and each railroad has its own design for the use of these materials to suit the conditions prevailing.

Your committee does not recommend any one material for each facility, since the conditions of traffic, the elements, the availability of materials, etc., will necessarily affect the choice.

Committee—T. H. Strate (chairman), div. engr., C. M. St. P. & P., Chicago; W. F. Hutcheson (vice-chairman), asst. supv., b. & b., C. & O., Newport News, Va.; L. E. Peyser (vice-chairman), asst. arch., S. P., San Francisco, Cal.; R. C. Baker, supv. b. & b., C. & E. I., Danville, Ill.; Maxfield Bear, est., C. & N. W., Chicago; G. W. Bensen, supv., b. & b., C. of Ga., Macon, Ga.; Armstrong Chinn, ch. engr., Alton, Chicago; H. M. Church, gen. supv., b. & b., C. & O., Richmond, Va.; G. V. Coffey, asst. supv., b. & b., M. C., Jackson, Mich.; C. Djuvik, engr. of b. & b., T. C., Nashville, Tenn.; R. G. Hilton, asst. engr., M. P., Houston, Tex.; K. E. Hornung, arch. drftsm., C. M. St. P. & P., Chicago; N. D. Howard, managing editor, *Railway Engineering and Maintenance*, Chicago; J. A. Jorlett, mast. carp., Penna., Pittsburgh, Pa.; T. C. Saunders, engr. asst., T. & N. O., North Bay, Ont.; and C. U. Smith, general manager & ch. engr., Board Harbor Commission, Milwaukee, Wis.

Discussion

L. C. Winkelhaus (C. & N.W.) said that on his road considerable asphalt tile flooring—not mentioned in the report—has been used in connection with station modernization projects during the last two or three years, with very satisfactory results. It has generally been applied over existing wood floors. He recommended it for consideration because of its satisfactory service and reasonable cost.

The discussion then turned to the use of hardeners for concrete floors and various materials, for both surface applications and use as admixtures, and the methods of using them, were described. Inserted metal grids and the method of applying them were also described. Chairman Strate recommended the use of rubber-tired trucks where concrete floors tend to dust, and L. D. Garis (C. & N.W.) cited the use of rubber-tire casings to cushion steel truck wheels, saying that they give surprisingly long service.

The Repair of Steel Bridges

Report of Committee

BRIDGES are as important to the safety and usefulness of a railroad as links are to a chain. Just as the load capacity of a chain is limited by the strength of its weakest link, so are the locomotive and train load capacities of all or a section of a railroad limited by the strength of the weakest bridge. In the one case the links, and in the other case the bridges must be maintained in good order to sustain the loads for which they are designed.

The railroad slogan "Safety First" applies as appropriately to the care of railroad bridges as it does to the many other details of railroad operation. Bridges, like other railroad property, become weakened by wear, deterioration, and damage from accidents and various other causes and a constant search must be maintained to detect the weaknesses which develop from time to time in the parts of bridge structures, especially the steel superstructures in which the element of safety is very important.

Inspection, therefore, is a very important factor in the care and safety of bridges. It is also important that a bridge inspector have the proper training and experience and an inquisitive mind to search out the weakened parts and report such conditions understandingly. The more he knows about the theory of stresses, the better he can do this and give proper weight in his reports to defects in critical members and in unimportant members of bridges. He can also be helpful in suggesting types of repairs which will accomplish a useful purpose. Carefully prepared field inspection reports make it possible for the bridge office to prepare plans for adequate and satisfactory repairs where needed and avoid unnecessary and poorly conceived repairs.

It is important that adequate provision is made in the construction of a bridge to enable an inspector to get around over the principal parts with safety. In some cases catwalks, ladders and grab irons are necessary accessories for this purpose and if not provided in the original construction, they should be added as their need is demonstrated.

While an inspector should be equipped with a light ladder, bar, calipers and a carpenter's rule, sometimes an extension ladder and additional help are required to get at ordinarily inaccessible places, and it is necessary to move planking, ties, etc., in order to make detail inspection and



A. R. Harris
Chairman

measurements of parts of some bridges. It is always desirable to make a special inspection of steelwork that is ordinarily concealed but that is exposed during the renewal of timber and decks at the time of making repairs, when the assistance of the bridge gangs will be available.

Programming the Work

The inspection reports written during the year as soon as the inspections are made, form the basis for a program of repairs for the following year, except in emergency cases when conditions make it necessary to make repairs sooner. This program should be set up before the end of the year, listing each job separately, with an outline of the work contemplated and an estimate of the cost for authorization. While it is not necessary that detail plans of the repairs be made prior to preparation of this program, it is better to do so if time permits; otherwise the plans can follow later.

If the repair work, including the fabrication of repair parts, is done by company forces, a stock of steel sizes should be ordered for all or parts of the program as early in the year, following the preparation of the program, as possible to avoid delays in executing the work. Plans of practically all repairs should be made, not only to insure proper execution of the work, but also to have an office record of the repairs made from year to year. In case the repair work and the material therefor are handled by contract, there is even more need for com-

plete plans. Often, when repairs are under way, more extensive repairs are found to be necessary.

Field Organization for Steel Repair

Many railroads do all their steel repair work with company forces, organized into floating gangs of from 6 to 14 experienced ironworkers with a foreman. The number of the gangs depends on the size and nature of the work to be done. When larger gangs are required for any special job, two or more gangs are combined.

If welding in addition to the usual riveting methods is employed in making repairs, when it is practical to do so, it has been found desirable either to provide complete welding equipment for the gang or if a less number of welding outfits are available, they may be transferred from one gang to another as required. Only specially trained men should do the welding but they should also be able to do riveting in case there is not welding enough to keep them so employed continuously. The gangs should be under the direction of a general foreman or supervisor, who, in turn, works under the supervision of the bridge engineer.

Repairs

(a) Steel repairs can be studied conveniently by considering the various types of repairs to be made. The type to be made may be influenced by a consideration of the time available between trains, but generally it is possible to install new members without interruption to train schedules by the following method: Cut out rivets and replace them immediately with temporary bolts. When all the rivets have been cut out, remove the bolts, take out the old member, place the new member, and bolt it up temporarily. Then, at the gang's convenience, drive the new rivets.

(b) Repairs required on account of brine corrosion:

Riveted Cover Plates on Stringers and on Deck Girders Without Cover Plates. Where the top surface is not pitted severely, cover plates are added. Pitted surfaces cannot be leveled satisfactorily. The rivet spacing should preferably not exceed 6 in., to avoid the accumulation of rust between the cover plate and the old member. The rivets should preferably be countersunk (not chipped). If buttonheads are used, the ties may either be

grooved or bored to clear rivet heads, unless, as is done on some roads, the ties are placed on the rivet heads and the first train passing over the bridge is depended upon to press the ties down over the rivet heads.

Welded Cover Plates. Plates preferably not less than 10 in. wide, in order to get good tie bearing, are added to the top flange, using continuous fillet welds for attachment to the angles. Cover plates are added to the bottom flange, making the plates wider than the flange to permit downhand welding. The edges of the flange angles, where severely corroded, should be trimmed back to obtain a reasonable thickness for welding.

Additional Angles: Where the top flange angles are too greatly pitted and reduced in section for satisfactory application of new cover plates, additional flange angles are added immediately below the bearing flange angles. Timber fillers may then be placed tightly between the two sets of angles. Eventually the top angles will need to be replaced with new angles, but the lower top flange angles will maintain the strength of the flange while the upper top flange angles are being changed out. This type of repair has merit at locations where train schedules are frequent.

Tie Supports: Where the top flange consists of angles without cover plates and is too badly pitted to permit attaching cover plates, they are trimmed back to the face of the web rivet heads, and a new fabricated flange, composed of two angles and a cover plate, is placed over the old flange. Lower top flange angles are then added to make up for the flange section cut away and the new flange is bolted with long bolts to the lower top flange angles. This detail affords a good support for the ties. (An illustration of this detail appears on page 93 of the 1936 Proceedings, of this association.)

New Flanges for I-Beam Stringers: Holes are drilled in the webs under the flange to match the holes in new flanges composed of two angles, or two angles and cover plates. The top flange is removed by a horizontal flame cut just below the flange, and a new flange connected to the web of the stringers. This method may be economical where heavy stringers are involved and their replacement will entail the temporary removal of lateral bracing angles.

Cover Plates of Floor Beams: Where the corrosion is confined to a small area, the corroded part of the cover plate is cut out, replaced with a filler plate and spliced over with a new plate, or a plate with holes to clear the rivet heads is welded over the old cover plate. Another satisfactory method is to remove the corrod-



Renewing Cover Plates by Both Riveting and Welding Is An Effective Means of Girder Repairs

ed sections of cover plates and replace with new sections butt-welded to the ends of the old plates. These plates may be riveted to the old flange section. Where the top cover plate is badly pitted over most of the length, all rivets should be cut out, and a new cover plate installed, providing extra material to allow for corrosion. The rivets cut out are replaced temporarily with bolts to maintain traffic over the bridge until all the rivets are cut out.

Floor Beam Webs: These become corroded as a result of brine splashing against the web on the side facing traffic. Patch plates are placed over the corroded area, preferably connected by welding to the end connection and the flange angles.

Bottom Flange Repairs: Where the bottom flange angles have corroded, it is not logical to apply cover plates on the bottom as the corrosion will continue on the flange angles. Instead, plates or angles should be riveted or welded to the upper side of flange angles. The plates should be ground to clear the fillet of the flange angle and carried over to the vertical leg of the flange angle. On deep stringers without stiffeners, new flange angles are placed directly above the old flange angles. The new angles will shield the bottom angles from brine drippings.

Corroded End Stiffener: Where the corrosion is confined to the lower six inches of the outstanding leg, a plate is riveted to this leg, taking the precaution to drift tight against the flange before riveting. Additional short stiffeners may be added between the existing stiffeners, but the bearing base details should be checked to see that the new stiffeners will not create high bending stresses in the top of the base.

If welding is used, the corroded part of the stiffener is cut out, and a new plate butt-welded to the stiffener and V-welded to the bottom flange. The A.R.E.A. Specifications sanction

the welding of the end stiffeners to the flange. It would appear desirable always to weld the stiffeners to the flange, as the flange will be corroded, and a good bearing cannot be obtained by simple contact.

Stringer Renewals: Where the old stringers are of good rating, two to four new stringers can be furnished, and the old stringers taken out and repaired on the ground, and then re-erected in a new location.

Bottom Flange of Girder at Bearing: Frequently the outstanding legs of the flange angles are corroded, or the flange angles just outside of the sole plates have been bent down $\frac{1}{4}$ in. to $\frac{1}{2}$ in. A suitable repair is to remove the sole plate and cut off the corroded or crimped outstanding legs, making a horizontal cut through the vertical legs and web of the girder. Then a new plate is inserted to take the place of the legs of the flange angles cut away, and a new sole plate, extending about two feet beyond the bearing, is installed to splice to the flange beyond the bearing. This detail requires welding. Where both legs of the flange angles are corroded, a short length of the angles should be cut out, and a new section installed, using lap angle splices outside of the bearing.

Corroded Webs Above the Rail Plate Floor, or Solid Floor: Around terminals there is an accumulation of dirt and cinders along the corner between the web and the floor, and the web may be corroded entirely through. Welding is the best means to apply patch plates, which are seal-welded to exclude moisture.

Repairs to Stringer Flanges Required on Account of Fillet Cracks Resulting from Bending of Ties, or From Other Causes: At the ends of stringers, fillet cracks will frequently be found, apparently caused by the deflection of the tie. Short angles are riveted inside the flanges and serve the dual purpose of supporting the flange and preventing the extension of the fillet crack. Where the fillet cracks occur at points other than the ends of stringers, it appears preferable to renew the flange angles, using thicker material.

Connection Angle Repairs: Due to continuous beam action at stringer connections, the connection angles are frequently cracked through the fillet, or through the material between rivet holes in the outstanding legs. The connection angles should be renewed with heavier angles. In case the stringers are long and flexible, it may be well to redesign the connections, using two lines of rivets in each connection, and cutting down the depth of the connection. This method has proven satisfactory in the case of 110-ft. twin

span turntables where the flexing of the connection angles at the loading girders results in fillet cracks at the top and bottom.

Bearing Repairs: Cracked cast iron bases should be replaced by welded bases, which are more economical than cast bases. The welded bases may have the same make-up of ribs and top and bottom plates as the old bases, and be welded at all intersections with $\frac{3}{8}$ -in. fillet welds. No annealing of the welded base is necessary. The top and bottom surfaces will require planing after welding, and the thicknesses of the top and bottom plates should allow for this planing. Where the stiffener layout is favorable, the new welded bases may be made of a simple design, using a less number of ribs than in the old base. It is well to provide additional holes in the base so the anchor bolts can be placed in new locations. The old bolts may be cut off to save the expense of jacking the span high enough to allow setting the bases over the old bolts.

Shims: At many bridges there is an accumulation of steel shims which is the result of surfacing the bearings to overcome wear or settlement, and raising the bridge to conform to the track. Where there is a large accumulation of shims, the girders often shift on the bearings. The individual shims should be edge-welded together to form a single unit, or else replaced by a new slab or pedestal. At old bridges, the masonry bearing is generally inadequate, and the replacement of the shims affords opportunity to furnish a new steel bearing slab of greater area. At such locations the masonry under and outside the bearing should be dressed down to a level surface.

Where the shim thicknesses are small, it is desirable to place the shims between the sole plate and pedestal.

Setting Bases: Where the bridge seat is at correct elevation, dry cement may be used to level off irregularities. Wet sacks can be laid around the base and the cement will abstract sufficient moisture to set. Sheet lead, or canvas saturated with red lead, or a rust joint may also be used to smooth out irregularities.

Rivets, Machine Bolts and Rib Bolts: Rivets are desirable for all connections. At isolated locations where a compressor is not available, bottled compressed air may be used for driving rivets, or machine bolts or rib bolts may be used for unimportant bracing connections. If bolts are used, it is essential that lock washers or lock nuts be used. Rib bolts must be large enough to drive tightly, or they will loosen up and not be satisfactory.

If the steel members have not separated, corroded rivet heads are built up by welding, using a bead weld

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around the periphery of the shank and taking precaution to secure good penetration.

Eye-Bars of Trusses: Frequently one of the several eyebars of a member will be loose and not tighten up when the span is fully loaded. Such a bar may be shortened by heating with acetylene torches and up-setting. This method is satisfactory and economical. Another type of repair used is to cut out the bar and install a turnbuckle. When the pin and all of the bars are worn, the bars should be reborbed and a larger pin installed, but this should not be so large as to reduce the section of the bar materially. When the bars have been reduced in section by blast in the center of the panel, bars may be welded to the sides of the eyebars to restore their original strength. In many old light truss spans, the panels near the center of the span do not have counters, and the diagonal eyebars will slack up for a certain position of the live load. Counters may be added by placing yokes around the pins or around the heads of bars.

Railing Repairs: The old pipe railings are usually of thin material and the posts break off near the bottom of the threaded connection. The pipe posts should be removed and angle posts installed, connecting the railing by U-bolts or by special fittings.

Turntable Repairs: Most of the repairs are required on account of corrosion, but there are a few points that deserve special mention. The friction at the center may develop a large bending force at the bottom flange of the loading girder. In one instance all of the cover plates had transverse cracks at the edge of the center bearing. Bracing was installed to relieve the flange of transverse bending stresses. On through plate girder turntables, it is important that the span be level in a horizontal plane; otherwise the girders will be forced back and forth in a scissor-like fashion, and complaints will be made that the span does not have sufficient stiffness or bracing. At one such location, a tapered steel shim was placed over

the center bearing, leveling up the span properly, and all of the operating troubles complained of disappeared.

Allowance for Corrosion

Where repairs are required, the new material should generally be of heavier section to provide against breaks or to allow for corrosion. Special alloy steels, or wrought iron may be considered. Wrought iron has proved to be more corrosion-resistant than ordinary steels, but the alloy steels have not been in service long enough to prove their value. It is doubtful whether the ordinary copper-bearing steel should be considered corrosion-resistant steel.

Welding

Welding possesses a great advantage over riveting in that in many instances material may be added to existing steel work without cutting out rivets, and thus temporarily reducing the strength of the structure. It also has the advantage that material may be applied with less interference to traffic than by riveting.

Research at the University of Illinois indicates that welded joints compare favorably with riveted joints under repeated loadings up to 2,000,000 cycles. A properly prepared butt-welded joint appears to be more free of localized stress concentrations than a riveted joint, and considering that 20 per cent of the net section is lost in the riveted joint, welded structures will show 10 per cent to 20 per cent saving in weight over riveted structures. The butt-weld should always be employed for compression or tension members where practicable in preference to fillet welds, as fillet welds have stress-raising characteristics.

Committee—A. R. Harris (chairman), asst. engr. br., C. & N. W., Chicago; A. B. Chapman (vice-chairman), off. engr., C. M. St. P. & P., Chicago; J. M. Salmon, Jr., (vice-chairman) asst. div. engr., L. & N., Middleboro, Ky.; H. M. Buell, br. insp., U. P., Omaha, Neb.; R. W. Cassidy, asst.

Welding Is Being Used Extensively in a Wide Range of Repair Work on Steel Bridges



cost engr., C. & O., Richmond, Va.; P. C. Chamberlain, br. insp., Erie, Port Jervis, N. Y.; D. W. Converse, asst. engr., A. C. & Y., Akron, Ohio; L. M. Frost, supv., b. & b., G. T. W., Battle Creek, Mich.; J. E. Heck, br. insp., C. & O., Peru, Ind.; A. M. Knowles, asst. engr. str., Erie, Cleveland, Ohio; I. A. Moore, trainmast., C. & E. I., Salem, Ill.; R. H. Morrison, supt., b. & b., Ban. & Aroos., Houlton, Me.; G. L. Sitton, ch. engr. m. of w., Sou., Charlotte, N. C.; and J. J. Wishart, supv. b. & b., N. Y. N. H. & H., Boston, Mass.

Discussion

G. S. Crites (B. & O.) referred to the statement in the report that "the masonry under and outside the bearing should be dressed down to a level surface," and suggested that the surface outside the bearing should slope slightly to drain moisture away. L. D. Garis (C. & N.W.) emphasized that one of the important problems in bridge inspection is to determine how far corrosion and loose rivets may be allowed to go before repairing. W. C. Groth (C.G.W.) said that they had restored a lot of brine-eaten rivet heads by welding, running one fillet around the rivet head. Chairman

Harris replied that this is practical if the rivet is not too far gone, and the plates are not sprung apart, and added that welding repairs to bridges are very convenient in that detailed designs are not necessary, as for riveted repairs.

A. M. Knowles (Erie) explained that his road had built up rivet heads by welding for many years, and in some cases, was employing a metal form set over the rivet head.

Mr. Garis pointed out that in building up rivet heads, the reduction in section should be considered. In some cases where the heads have snapped off, he said that it is economical to weld on new heads. A. B. Chapman (C.M.St.P. & P.) said that they had found very few cases where it was cheaper to build up rivet heads by welding than to remove the old rivets and redrive new rivets. In cases where the rivets have corroded so much that they have started to "bleed," he contended that they are so nearly gone that they should be replaced. In this connection, Mr. Crites mentioned the replacing of corroded rivets in the underside of over-head highway bridges. In such cases, he said, it was necessary to build

up the heads by welding, because the rivets could not be redriven without tearing down the bridge.

The tightening of eye-bars in old truss spans was then discussed at considerable length, and J. S. Hancock (D.T. & I.) said that the welded turnbuckle units installed to tighten eye-bars on his road have been entirely satisfactory so far. Mr. Chapman described a recently developed method of flame shortening eye-bars used on the Milwaukee, by means of which they have shortened bars as much as $1\frac{1}{4}$ in. by simply heating sections of the bars with acetylene torches and allowing them to cool. He stated, for example, that if a section 12 in. long is heated to 1600 deg. F. and allowed to cool, the eye-bar will be shortened $\frac{1}{8}$ in. By successively heating several sections in this manner, he pointed out, loose eyebars can be shortened until they bear the desired amount of initial stress. Mr. Chapman explained that two torchmen heat the eye-bar simultaneously on both sides and a pyrometer is used to make certain the temperature does not exceed 1600 deg. F. He said that before adopting this method on a large scale they tested several eye-bars after heating.

The Cleaning of Masonry Buildings

Report of Committee

A BUILDING is essentially only a shelter to protect operations from the weather and to furnish storage space for the necessary tools, other equipment and records made necessary by the operation involved. There are many types of buildings used for a wide variety of purposes, but in the last analysis they are only shelters which make the operations possible and permit them to be carried on in an efficient manner. In theory, so long as a building is weathertight and clean enough to permit operations to be carried on, no further requirements should be necessary.

We do, however, live in a complex world and items which, in themselves, would not be considered by a strictly utilitarian efficiency unit (or person) can affect the not-so-efficient fellow workers, other occupants, customers and the general public in a manner which may tend to nullify the operations conducted by cold-blooded efficiency and strict utilitarianism. Just how far these extraneous items should be considered is questionable, but under-stressing or over-stressing them should be avoided.

In dealing with the general public



W. A. Huckstep
Chairman

in competition with others in similar lines there is, in most instances, not much difference in the item produced, but there may be a vast difference in how it is done. Operations conducted in clean, cheerful surroundings, both inside and outside a building, usually

cost little more than those conducted in indifferent surroundings; however, the effect of clean surroundings on the general public creates good will which has a definite value.

Desirable high-class tenants may put up with the dirty and dingy exterior of their buildings for a while, but sooner or later competition from similar firms located in clean surroundings is going to be felt and the tenants will go to landlords more in touch with the attitude of the general public. In many cases migration from a once first-class business district to another location and the starting of a movement of the business district in a certain direction are due entirely to the fact that the general public prefers clean surroundings. Once a first-class business district has lost its primacy, in most cases nothing will bring it back.

Cleaning Large Buildings

Following are the various methods of cleaning structures of stone, brick, terra cotta, granite, marble, monolithic concrete, and stucco on tile.

(a) *Sandblasting* — This is the method where particles of sharp sand

are blown by a jet of air or water against the surface to be cleaned. Pressures of 700 to 800 lb. per sq. in. may be used in both wet and dry sandblasting, but in building cleaning work with dry sandblasting, 75 to 100 lb. per sq. in. is used most generally.

Producers of high grade building stone, as well as manufacturers of building brick and terra cotta, recommend against the use of sandblasting methods for cleaning surfaces of buildings constructed with such materials. It is conceded that about the only buildings today on which sandblasting may be used without any appreciable deleterious effect are those constructed of rough stone. Sandblasting is definitely injurious to mortar joints and when this method is used, it should be followed by tuck-pointing. Steel bridges, steel tanks and other structures which are constructed of steel and iron are cleaned more effectively by sandblasting.

(b) *Acid Washing*—On new brick buildings the surface of the brickwork is customarily gone over with a wire brush, after which a 10 per cent solution of muriatic acid in water is applied by hand, followed by thorough rinsing of the surface with clean water, under pressure, to remove the acid. The purpose of this treatment is to remove stains and discolorations that occur during construction.

Some building cleaning companies employ hydrofluoric acid as a cleansing agent on buildings where excessive carbonization has set up or where there is an unusual amount of discoloration. This acid sets up a very destructive chemical action unless it is thoroughly neutralized and entirely washed off immediately after application.

Where glass, granite, marble, tile, terra cotta or limestone is found in combination with other building materials which are to be cleaned with hydrofluoric acid, the foregoing must be covered with melted paraffin, brushed on. As an added precaution, the surfaces should be kept wet while working near them. The paraffin should be removed with paper only.

Extreme care is required on the part of workmen applying this acid and rubber gloves, goggles, long handle brushes, etc., must be used to avoid personal injury. Likewise, extra precautions are required to protect pedestrians and adjacent property from injury or damage.

For these reasons hydrofluoric acid washing should never be undertaken by other than persons experienced in its use and even then it is not recommended as more or less deleterious effects are always noted subsequently.

An outstanding producer and fabricator of structural granite recom-

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mends two methods for cleaning polished and dressed granite. (1) Spray or sprinkle the surface of the granite with muriatic acid, then brush vigorously with a stiff brush and plenty of water and rinse thoroughly. Particular attention is directed to the fact that with polished surfaces it is important that the acid does not remain on the surface in full strength for more than a few seconds; otherwise the gloss finish will be dulled. (2) Apply non-inflammable, white gasoline



After Cleaning a Structure, All Defective Mortar Joints Should Be Cleaned Out Thoroughly and Tuck-Pointed

in the same manner as directed for muriatic acid. The granite company above referred to is now using this cleansing agent.

(c) *Steam Cleaning*—After several years of experimentation, the so-called steam cleaning process, a new and efficient method for cleaning stonework, has been developed, whereby a very finely divided spray of steam and water is projected against the building at a high velocity. Entering the minute depressions in the surface, it dissolves or dislodges and carries away grime, soot and other extraneous matter that may have been deposited on the exteriors.

The detrimental effects of both the "sand-blast" and "acid-wash" methods employed by the average commercial contractor are well known. Sand-blast tends to dull the sharp arises and blur the ornamental detail and carving, and invariably roughens the surface, cutting through the protective skin and thus opening the pores and thereby destroying to a great extent the well-known grime-resisting and self-cleansing properties of limestone. Acid-wash, besides having a tendency to eat into and pit the

stone, usually exerts a bleaching action, causing the stone to present an unnatural appearance and sometimes causing it to turn a yellow color later on. Furthermore, when the acid solution is not thoroughly washed away, the destructive chemical action that may result, due to the chemical left in the pores of the stone, will often continue for some time, even years, after the cleaning is done.

The steam cleaning process developed and now in commercial use by reliable cleaning concerns in many parts of the United States, is far superior to the "sand-blast" and "acid-wash" methods and is more economical and dependable. While the process has been developed primarily for cleaning limestone buildings, it is now employed quite generally for cleaning brickwork, terra cotta, granite and sandstone.

After cleaning by this process, an old stone building invariably presents a natural weathered appearance, retaining its natural surface and original color-tone with no suggestion of the roughened surface, dulled arises and carving resulting from sand-blast, or the dead, bleached tone which is so noticeable with most of the stone buildings that have been subjected to acid-cleaning treatments.

Suitable for New Stone

This method of cleaning is suitable not only for old buildings but also for cleaning down new stonework. New stone cleaned with steam usually has a greater apparent range of color-tone and texture than when cleaned by hand because of the greater effectiveness of the steam jet and water in removing from the pores of the stone the stone dust and dirt which accumulate during the cutting and setting of the stone.

The following rates per nozzle have been reported, with steam at about 150 lb. per sq. in. The commercial cleaning rate usually runs from 5 cents to 10 cents per sq. ft. of surface cleaned.

Building in Boston, Mass.

1500 sq. ft. per 9-hr. day for new work.

1000 sq. ft. per 9-hr. day for old work.

Building in Bedford, Ind.

Cleaned directly after completion—
2400 sq. ft. per 8-hr. day.

Building in Bedford, Ind.

Orginal building 15 years old—addition
3 years old—no discernable difference
between old and new stonework after
cleaning—1000 sq. ft. per 8-hr. day.

**Building in Washington, D.C. (marble
and brick)**

11 stories high and several years old.
Two nozzlemen working together, each
nozzleman cleaning 1000 sq. ft. per 8-hr.
day.

For steam cleaning of limestone

buildings the procedure recommended is as follows:

Steam should be generated in sufficient quantity to maintain the pressure required. A pressure of at least 140 lb., preferably 150 lb., per sq. in. is required for old and dirty buildings, although 100 to 120 lb. is usually sufficient for cleaning new buildings.

Steam and water are brought to the nozzle in separate hose, usually $\frac{1}{2}$ in. in diameter. The relative amounts of steam and water are controlled by quick-acting valves at the nozzle. Only sufficient water pressure is needed to carry the water to the nozzle, the velocity of the spray being imparted entirely by the steam.

The steam cleaning process, using high pressure steam and water, is rapid, practical and economical and does not injure limestone, sandstone, brick or terra cotta. No dust, dirt or chemical is left on the surface or in the pores of the stone to cause unsightly streaking of the building later during rainy weather.

High pressure steam or water vapor (140-150 lb. per sq. in.) should be used for cleaning old, dirty stonework, although new work may be cleaned with the ordinary boiler pressure of 100 to 120 lb.

(d) *Water Vapor Cleaning*—This is a method which employs the delivery of a substantial volume of vaporized water under high temperature from a nozzle giving a broad, knife edged, high velocity jet, with pressure sufficient to penetrate minute crevices and carvings to dislodge, dissolve and completely carry away alkali, acid, soot, etc. The nozzle is held a few inches from the surface and, starting at the operator's shoulder height, is moved in a horizontal sweeping motion, working down. Only clear water is used and it must be softened with water-softening compound.

The equipment used for vapor cleaning can likewise be used in applying mild acid, alkali and soap solutions where their use is desirable. This method consists of three operations:—pre-soaking thoroughly with water, or preferably with vapor; the application of the chemical solution of the desired strength, following the same procedure as for cleaning with vapor only; the rinsing of the surface again, using the same procedure as for cleaning with vapor. In switching from solutions to vapor, sufficient time must be allowed for the machine to clear itself (usually about three minutes). The rinsing of a section can be followed immediately by the pre-soaking of the next section, which gives a continuous operation.

Where it is desired to combine vapor cleaning with hand application of

chemical compounds, the method also consists of three operations; pre-soaking thoroughly both the section being cleaned and the adjacent area with water or preferably with vapor; the application of chemical by a suitable hand method (usually a brush); the thorough rinsing of the surface, following the same procedure as in cleaning with vapor only.

Chemicals: Where chemicals are to be used in conjunction with either steam or vapor cleaning, the first consideration is that they shall in no way affect or disintegrate the surface to which they are applied. The speed with which excess grease or dirt reacts to a chemical must be a secondary consideration.

Soap: For hand application up to 5 lb. to 5 gal. of water. For machine application up to 5 lb. to 50 gal. of water.

Provision should be made for overcoming the hardness of the water by using a water softening compound.

Cleaning Compounds—A number of manufacturers make chemical compounds for specific cleaning purposes and the kind to be used must be determined from the cleaning work to be done. Manufacturers provide instructions for their use.

Acid Cleaning

Acids—The following acids will meet nearly all requirements.

Oxalic—Mild oxalic acid does not attack glass or metal to any extent. Used also for neutralizing salt efflorescence. For application by hand, use 1 lb. of Oxalic acid crystals to six gallons of water. For vapor machine application, use up to 6 lb. for 50 gal. of water. Use no water softener when adding acid to a vapor machine solution tank for applying the solution from the machine, but for rinsing, soften the water in the regular manner.

Muriatic—Stronger, more powerful than Oxalic. Does not materially affect glass, works a little on mortar. Has a tendency to discolor light colored brick. For hand application, use 1 to 2 gal. to 10 gal. of water. Rubber gloves should be worn. For machine application, use 1 to 3 gal. to 50 gal. of water. Use no water softener when adding acid to the solution tank, but for rinsing, soften the water in the usual manner.

Hydrofluoric—Readily attacks silica and glass; therefore, all glass must have a protective covering, preferably of grease or paraffine. Very small areas should be cleaned at a time so that the acid does not begin to dry out before it is thoroughly rinsed. *This acid can be applied by hand only.* The

safety precautions already given under the heading "Acid Washing" should be carefully observed. Solution strength, one-half to one pint of commercial acid to five gal. of water. The use of this acid is not recommended except in extreme cases.

Types of Surfaces

Brick—Yellow, buff and all light-colored press brick may be cleaned with steam or vapor only, or cleaning compounds. Tapestry, ruffles and red common brick may be cleaned with a cleaning compound in conjunction with steam or vapor. Glazed brick may be cleaned with soap or a cleaning compound if a cleaning agent is desirable. Never use hydrofluoric acid.

Terra Cotta—Glazed or unglazed. May be cleaned with steam or vapor only; cleaning compound or soap. Never use hydrofluoric acid.

Granite—Refer to portion of report under caption of "Acid Washing."

Marble—May be cleaned with steam or vapor only; soap or cleaning compound.

Removal of Stains

Following are some methods recommended for the removal of various types of stains from masonry:

Paint Stains—For fresh paint, apply a commercial paint remover, or a solution of tri-sodium phosphate in water—2 lb. of tri-sodium phosphate to 1 gal. of water. Allow to stand and remove paint with a scraper or wire brush. Wash with clear water. For old, dried paint organic solvents similar to the above may not be effective, in which case it must be ground off by sand blasting or scrubbing with steel wool, provided, of course, that the texture of the masonry surface is such that the possible injury thereto by this treatment will be compensated by the results gained.

Smoke Stains—Make a smooth, stiff paste of trichlorethylene and powdered talc and apply to the stain with a trowel. Scrape off when dried and repeat until the stain has disappeared, then wash thoroughly with clean water. Keep covered to prevent rapid evaporation. If a slight stain is left after several applications, wash thoroughly with the following:

Dissolve 2 lb. of tri-sodium phosphate in 5 qt. of water. In a separate vessel make a smooth, stiff paste of 12 oz. of chloride of lime in water. Pour the former onto the paste and stir thoroughly. When the lime has settled, draw off the clear liquid and dilute with equal parts of water. Make a stiff paste of this with powdered talc and apply in the same manner as

directed above. Precaution should be taken to ventilate a closed space in which trichlorethylene is used, as the fumes are harmful.

Coal Smoke Stain:—Scrub with powdered pumice and a wire brush. This is an alternate method to the one given above. Painters Magazine recommends a solution of one gallon of soft soap, two pounds of powdered pumice and one pint of liquid ammonia, beating the mixture well. Apply a fairly thick layer with a fibre brush, allowing it to remain about 20 minutes, then rub it in with a good stiff scrubbing brush, using plenty of elbow grease. Use a large sponge to

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of tri-sodium phosphate in a gallon of hot water. Mix 12 oz. of chlorinated lime to a paste in a shallow enamel pan by adding water slowly and mashing lumps. Pour this and the tri-sodium phosphate into a stoneware jar and add water until approximately two gal. are obtained. Stir well, cover the jar and allow the lime to settle. In using this on tobacco stains, add some of the liquid to powdered talc, mix until a thick paste is obtained and apply as a poultice one-fourth inch thick with a trowel. If it is desired to apply this with a brush, add about one teaspoon of sugar to each pound of powdered talc. When dry, scrape off

then wash thoroughly with clean water.

(3.) Iron stains can be removed with sodium hydro-sulphite. As a preliminary treatment, dissolve one quart of sodium citrate in six parts of water and apply this to the stain by saturating white cotton in the solution and placing it over the stain. Leave this on the stain while the materials for the following treatment are being prepared:

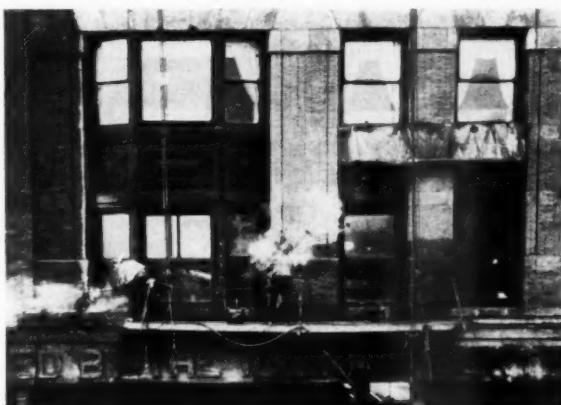
If the stained stone is in a horizontal position, sprinkle a thin layer of hydro-sulphite crystals over the stone, moisten with a few drops of water and cover with a thick paste made of whiting and water. If the stain is in a vertical position, place the whiting on a plasterer's trowel, sprinkle a layer of hydro-sulphite crystals on the face, moisten slightly and apply it over the stain. Leave this for one hour and remove. If the stain is not all removed, repeat the operation. When the stain disappears, rinse the surface thoroughly with clear water and make another application of the citrate solution, as in the first operation. The purpose of the sodium citrate treatment is to prevent the reappearance of the stain. Occasionally, in treating iron stains with sodium hydro-sulphite, the original brown stain may change to black. If hydrated lime is used instead of whiting for the poultice, this nearly always occurs. In case a black stain occurs, it should be treated with hydrogen peroxide until it is oxidized back to a brown color; then proceed with the hydro-sulphite treatment as above.

Green Stains: (From copper and bronze)—Such stains are usually found on the bases of bronze statuary or where bronze plates are attached to stone. The stains are nearly always green, but bronze apparently causes brown stains in some cases.

Scrub the stone with a dilute solution of potassium-cyanide containing from one to two ounces of the cyanide per quart of water, or in lieu of this use a sodium-cyanide solution of the same strength for the scrubbing of stone. This will generally remove such staining completely and leave no apparent bad effects on the surface of the stone. It is advisable to follow this treatment by a thorough drenching of the surface with water from a hose. It should be kept in mind that potassium-cyanide is very poisonous and in that respect is dangerous to use, so operators should be equipped with rubber gloves.

Blood Stains:—Wet the stain with water; then dust over with a thin, even layer of sodium peroxide. Then sprinkle with water. Care must be taken not to breathe any of the peroxide dust or allow it to come in contact with the skin as it is very caustic.

Dilute Muriatic Acid, Followed by Washing With Hot Water and Steam Removed a Heavy Incrustation of Dirt and Soot From this Building



remove the lather and then rinse with clear water. This, if properly done, will remove the most stubborn case of discoloration by coal smoke.

Oil Stains:—(2 Methods) (1.) Make a paste of a solution of one pound of tri-sodium phosphate to one gallon of water and whiting. Spread this paste in a layer about one-half inch thick over the surface to be cleaned and leave until it dries, approximately 24 hr. Remove the paste and wash surface with clear water. (2.) Saturate a blotter with either amyl acetate or benzene and place it over the stain, making sure that the blotter extends well over the boundaries of the stain. Place a hot iron, or preferably a hot slab of stone, over the blotter. This hastens the evaporation of the solvent and consequently hastens the removal of the stain. Where the stain is hard to remove, the treatment must be repeated.

Tar Stains:—Scrape off all the tar possible with a sharp edged instrument, being careful not to smear the adjoining surface during the operation. After this has been done, follow direction No. 2 for the removal of oil stains, taking care to change blotters after the old one has become saturated with tar. The operation usually has to be repeated several times.

Tobacco Stains:—Dissolve two lb.

the poultice with a wooden paddle. This mixture is a strong bleaching agent and is corrosive to metals; hence in using it, care should be taken not to drop it on colored fabrics or metal fixtures.

Iron Stains:—Brown cement stain should not be confused with brown stain caused by rusting ironwork simply because they may have a similar color and appearance, as rust stains will only be found where the masonry adjoins rusting ironwork.

The following treatments have each been used successfully for eliminating brown rust stains:

(1.) Scrub with a hot concentrated solution of oxalic acid. The objection to this is that this acid may cause some noticeable etching of the surface of the masonry, but this is not usually very bad because of the formation of an insoluble calcium oxalate film on the surface of the masonry. Where used, it is advisable to follow this application with a thorough drenching with water from a hose.

(2.) Mix seven parts of lime-free glycerine with a solution of one part sodium citrate in six parts of lukewarm water and make it a thick paste with whiting or kieselguhr. Apply the paste to the stain with a trowel and scrape it off when dried out. Repeat until the stain has disappeared, and

Allow the peroxide to remain a few minutes, then scrub vigorously with copious amounts of water. This removes the stain and it is seldom necessary to repeat the operation. After the sodium peroxide has been washed off, scrub with a ten percent solution of formic acid. The acid wash neutralizes the last alkaline traces left by the sodium peroxide. It is best to see a druggist regarding the dilution of the formic acid.

Brown Stain and Discolorations:—No treatment, so far, has been found successful for the removal of the brown stain due to staining cements when the wall is wet. For this reason, before any treatment is undertaken for its removal, all leaks into the wall must be stopped. Many people prefer not to attempt artificial removal of this stain for, when the wall dries out, natural weathering agencies will usually remove it in a short time, leaving no trace behind.

If the stain covers a large area, clean it off with steam, under approximately one hundred pounds pressure, ejected from a flat nozzle. This is easily done by simply playing the steam over the stain until it is removed. This treatment must be followed immediately with a scrubbing with a ten percent solution of formic acid.

If small areas are to be treated or if the use of steam is not advisable, the following poultice treatment may be used. Mix paper pulp or some other fibrous material with enough fireclay to give it workability when moistened. An alkaline poultice and an acid poultice are made from this.

Mix part of the semi-dry paper pulp-fireclay mixture with a solution containing 3.8 oz. of sodium carbonate per gallon of water until it can easily be worked under a trowel. Plaster this over the stain, extending it to the edges of the stone that is being treated. After twenty-four hours remove the poultice. Due to the paper mat, it will peel off easily, leaving the stone nice and clean. This is followed immediately with a poultice made from the unused semi-dry paper pulp-fireclay mixture moistened to a working consistency with a ten percent solution of formic acid. This second poultice prevents the immediate recurrence of the stain.

Formic acid may be purchased in varying concentrations and a druggist or a chemical supply house should be seen regarding its dilution.

Steam Equipment

(d) **Machines:**—Several methods have been employed successfully for the production of steam:

An ordinary high pressure steam boiler is perhaps the most common

source. A boiler capacity of about 12 hp. per nozzle is required. One company has developed a special oil-fired portable steam plant weighing about 2,000 lb., and costing about \$1,600, exclusive of truck mounting, with a capacity of one large nozzle or two small ones. Another company manufactures a steam machine weighing about 1,000 lb. in the stationary type, and 1,300 lb. in the portable type, costing \$645 up, depending upon the auxiliary equipment and type of unit purchased. A cleaning unit is now being manufactured by still another company which, in a trailer type, sells for approximately \$1,000; in a portable type for approximately \$850, and in a stationary type for about \$750. There is still another company which produces water vapor machines which are available in several portable, trailer and stationary types.

Tuck-pointing and Caulking

(a) **Mortar, Color, etc.:**—After the wall surface has been cleaned, in most cases any defects in the mortar joints will show up very plainly. All defective mortar joints should be thoroughly cleaned out and pointed up with mortar consisting of proper proportions of well-graded sand, cement and lime putty, with the addition of such coloring matter as may be required to match the color of existing joints. Before proceeding with the tuck-pointing, two or three samples with different amounts of added mortar color should be prepared to obtain the correct color matching.

(b) **Caulking Around Windows:**—It is generally found in buildings that the joints between the window and door frames and the masonry walls will leak air and allow dirt to sift in. These joints should be thoroughly caulked with an elastic non-drying, non-staining compound which can be forced deep into the narrow cracks with a pressure gun. In addition, parapet walls which have copings of stone, terra cotta or pre-cast concrete blocks can be sealed more tightly and effectively with a good caulking compound than if re-pointed. There are several recognized good brands of caulking compound and it is important to exercise care in selecting the brand to be used.

It is inadvisable to say that any one particular method is superior to all others for all cleaning purposes, for each has its specific field. The following methods, given in preferential order as regards their possible deleterious effect upon a building, cover almost any building cleaning which may become necessary:

- Water vapor cleaning
- Steam cleaning

Acid washing (excluding hydrofluoric acid)
Sandblasting
Hydrofluoric acid washing.

The first two methods will, in most cases, be more economical and cause less disturbance of normal operations in and about the premises being cleaned. Either method can be combined with the use of commercial cleansing solutions and thereby produce satisfactory results in almost all cases except buildings where excessive carbonization has occurred on the masonry surfaces.

So-called bleaching agents, which some building cleaning contractors recommend, have not proven so far to be entirely satisfactory. While they will bleach the masonry surface, this effect is usually maintained for a short time only, after which there is a noticeable yellowing of the surface.

Quite naturally there will be some difference of opinion as to advisability of cleaning railroad buildings with railroad bridge and building forces. There seems to be no substantial reason why masonry buildings cannot be cleaned by bridge and building forces, if they are furnished proper equipment and given complete instructions in the method to be followed. After determining the method which seems most suitable to the particular type of cleaning work to be handled, the necessary portable equipment and appurtenances can then be obtained. Manufacturers furnish complete instructions for the operation of their equipment and usually will furnish an experienced man to give a practical demonstration in its use.

Building cleaning by bridge and building forces, however, has its limitations. All buildings over two, or possibly three stories in height and probably also all buildings located in large cities where reputable building cleaning contractors operate, should be cleaned by contract. In the first instance, it would be expensive to provide additional hoisting cables, hose and other accessories for the higher operations, for the comparatively few instances they would be required. Further, only men who follow building cleaning work as a regular vocation should handle and work from scaffolds at heights of more than two or three stories. In the second instance, building cleaning contractors are generally familiar with local ordinances governing such work in cities and it is possible that local ordinances provide that such work can only be done by licensed contractors.

Eliminating the buildings covered by the preceding paragraph still leaves the bulk of the masonry buildings to be found on most large railroads as a possible field for cleaning operations

by bridge and building forces. Undoubtedly a considerable saving can be effected by using these forces for building cleaning operations, particularly where the buildings to be cleaned are remote from cities where reputable contractors are located. The cleaning of railroad buildings, particularly passenger and freight stations, office buildings, etc., is definitely important and the success of doing such work by bridge and building forces depends upon the effort put forth by supervisory officers in obtaining all available information as to methods, use of equipment, cleaning compounds, etc., and seeing that it is received and understood by the foremen who are to execute the work.

Incidentally, the portable type of

Railway Engineering and Maintenance

cleaning equipment referred to earlier in this report is also adapted to the cleaning of gasoline motor cars, trucks, buses and equipment where grease, oil and dirt accumulate, and in pre-cleaning frame buildings before repainting.

Committee—W. A. Huckstep (chairman), gen. superv. bldg., M. P., St. Louis, Mo.; H. M. Harlow (vice-chairman), asst. superv. b. & b., C. & O., Clifton Forge, Va.; F. W. Dayton, arch. draftsman, C. & N. W., Chicago; L. C. Hinsch, instrumentman, C. M. St. P. & P., Savanna, Ill.; C. Holland, asst. engr., C. M. St. P. & P., Minneapolis, Minn.; F. L. Koehler, div. engr., C. & O., Ashland, Ky.; S. E. Kvenberg, asst. engr., C. M. St. P. & P., Chicago; M. Meyer, superv. b. & b., C. & W. I., Chicago; K. L. Miner, superv. b. & b., N. Y. C., Albany, N. Y.; H. J. Powell, paint-

er foreman, N. Y. C., Malone, N. Y.; F. R. Spofford, superv. b. & b., B. & M., Boston, Mass.; M. Stein, engr. draftsman, C. & N. W., Chicago; J. S. Vreeland, asso. ed., *Railway Engineering and Maintenance*, Chicago; L. C. Winkelhaus, arch. engr., C. & N. W., Chicago; H. O. Wray, engineer maintenance of way, Tex. Cent., Texas City, Texas.

Discussion

In a short discussion, Chairman Huckstep explained that the many commercial caulking compounds available have widely different properties, and suggested, therefore, that before purchasing a caulking compound, one should investigate it carefully to be sure that it will be suitable for the work in mind.

Conserving Bridge, Building and Water Service Materials

Report of Committee

THE conservation of materials is not new to bridge and building men, having been followed since the first railroad was built. While it has always been important, it probably was never as important as at the present time. Heretofore it has generally been a matter of primary concern to the railroads alone, but now it affects the welfare of the entire nation.

Reasons for Conservation

The reasons for the conservation of materials are varied and the importance of these reasons has also varied at different times. One reason which we have always had with us is that of economy. It always has been—and of course always will be—good practice to make use of secondhand materials and equipment where such use in the long run is more economical than the purchase of new materials and equipment. Often, however, the use of secondhand materials is brought about through the inability to purchase like new materials. During the depression this was prevalent because the low earning power of most railroads made funds unavailable to buy new equipment and materials, even when it was economical to do so. We are again faced with inability to obtain many of the things which we need or could use economically, not generally because of lack of funds but because of the great need of these same materials by our armed forces, and we are again faced with the necessity, regardless of the economics thereof, for substituting old for new, which is merely another way of saying "conservation of materials." This goes even further than the mere



F. G. Campbell
Chairman

inability to obtain new materials since it is now our patriotic duty to avoid, in so far as possible, the use of any of the critical materials needed in national defense, or offense, even when we can secure them. Therefore, our first thought must not be, "Can I secure the new materials and equipment which I need" but, rather, "Have I anything old which I can use?" and thus avoid or postpone even the endeavor to secure new materials and equipment. Because of present conditions, it is the purpose of this report to go to the limit in conservation of materials, regardless of the economies thereof.

One important phase of the conservation of materials is the securing of the maximum life of materials in

initial service. This is generally good maintenance practice at any time, since it will usually result in economies. At this time more frequent and probably more careful inspections should be made of our present structures. Steel structures should be cleaned and painted with sufficient frequency to reduce to a minimum loss through rust or other corrosive action. Wood structures should be kept tightened to avoid mechanical wear and, wherever necessary, should be painted to retard decay. All materials in service should be kept as free as possible from moisture and dirt. Minor repairs to composite structures, such as roofs, should be made whenever opportunity arises. This may not always be economical but will conserve materials since it will postpone the time when renewals of entire facilities must be made.

Use of Welding

The welding torch has proved to be of marked aid in the prolongation of the service life of steel structures. When girders are reduced through corrosion near the end bearing plates to the extent that they need repairs, the wasted steel can be restored to its original strength by welding plates on the angles and webs. These plates can often be secured from our stores of secondhand materials.

Some of our older steel structures were designed for lighter loads than they are now required to carry. Many of these structures can be strengthened by welding to them additional stiffener angles or other additional support, thereby keeping in service for

a number of years structures which would otherwise have to be replaced through a large expenditure of steel for a new structure.

Greater Use of Secondhand Materials and Equipment

Whenever it is necessary to build a new facility, to acquire new equipment, or to make extensive repairs to existing facilities and equipments, a careful check and inspection should be made of all secondhand materials on hand which may possibly be of use, before ordering any new materials. The general scrap dock often proves to be a source of such materials. Often materials which cannot be used by another department, can be used to advantage by the bridge and building department. This is true especially of materials scrapped by the car department through the dismantling of cars. As a minor example, reasonably good rail clips can be made from car scrap. Car rods can be threaded and made into bolts. Scrap steel plates from gondola and hopper cars make excellent bridge floors and can also be used extensively for the protection of ties from ash pan dumpings in the vicinity of coal and water stations. Planks from the sides of wood side gondola cars can be used extensively in platforms, temporary crossings, scaffolding, and for many other purposes. Car steel can be cut into satisfactory reinforcing rods.

A common type of construction for cinder pits is a heavy plate bearing upon the concrete wall to carry the running rail. Because of rapid deterioration, these plates have to be renewed frequently. Plate steel is now almost impossible to obtain. A very satisfactory substitute is the concreting of short pieces of scrap rail, base up, in the top of the wall. The running rail can then be clipped to these transverse rails.

Equipment can, when necessary, usually be continued in service almost indefinitely through repairs. True, this may not be economical, but under present conditions it must be done to the limit of our ability. Also new repair parts are now often difficult and sometimes impossible to obtain. Diligent search, however, will sometimes disclose that parts from discarded machines, possibly of an entirely different type, may be used. Often obsolete or worn-out machines, or major parts thereof, may be converted to other uses. For example, chassis of track-mounted air compressors and concrete mixers can be made into very acceptable heavy push cars. Cables, on cranes and hoists, which have become inadequate in their original location can be passed along to lesser require-

ments, thus considerably reducing the necessity for new cable.

Probably one of the most fertile fields in the conservation of materials, but also probably the one given the least thought, is the use of secondhand timber. We know of a recent case where a steel trestle had, through deterioration, become so weakened that it was approaching an unsafe condition. Under ordinary conditions,

it should at least be mentioned in passing. Steel is probably the material most needed in the greatest volume by our armed forces. The designer of new structures can greatly reduce the consumption of steel by the substitution of other materials, especially creosoted timber and concrete. The art of preservation of timber has now advanced to the point where its use in place of steel should be given

"Steel Structures Should Be Cleaned and Painted With Sufficient Frequency to Reduce to a Minimum Loss Through Rust or Other Corrosive Action"



this trestle should have been completely renewed in kind but this would have required a large amount of new steel. Temporary repairs were made by placing wooden helper bents along each side of the old steel bents. These wooden bents were made entirely of secondhand timber, most of which was recovered from a dismantled wooden coal chute and from the sound portions of stringers recovered from the renewal of a timber trestle. The job is not sightly and it was probably uneconomical; however, it will last for several years and the use of a large amount of new steel has been postponed, it is hoped, for the duration of the emergency.

A source of much valuable secondhand timber for the bridge and building man is the creosoted track ties discarded by the track department. Such ties are often removed from the track on account of splitting or spike cutting and contain no decay. Even when such ties are removed on account of decay, the decay is usually localized and the majority of the tie is still sound. These ties make excellent cribbing and retaining walls. Sound portions of such ties can also be used in the building of catch basins. In such use they will not, of course, last forever, but we believe that in these uses, where no mechanical wear is encountered, the length of their service life will be considerable.

The substitution, through change in design, of less critical new materials for those highly critical is probably not within the scope of this committee. It is, however, of such vital importance at the present time that we feel

careful consideration. While reinforced concrete does, of course, require some steel, its more extended use will greatly reduce our requirements for steel plates and shapes.

Salvage and Rehabilitation

In addition to the added thought which we must now give to the use of secondhand materials, we must give equal thought to the procuring of such materials. This leads us to a study of the proper methods of salvaging and rehabilitating used materials. Before any structure is dismantled, the building superintendent or engineer in charge should make a careful inspection to determine the best method of removing the materials with the least possible damage. This will probably require a great deal more labor than was used on similar projects in the past. He should probably plan to leave his cutting torch in the shop. During the past few years we have undoubtedly saved a great deal of money through the use of this very efficient tool; however, in making this saving, we have reduced to scrap a great deal of steel which could have otherwise been used. Now our major problem is not the saving of money but the saving of vital materials. Let us then, for the emergency, lay aside the cutting torch in so far as it is an instrument of destruction. In recovering steel members, it has been customary in the past to burn them off near the end supports, which facilitates removal but destroys the connecting members. If, however, we are to go the limit in our conservation

program, this practice must be discontinued and all members, even including bolts and nuts, must be carefully removed and saved. Salvaged steel should be cleaned and painted as quickly as possible, and if not reused immediately, should be carefully classified and stored.

In the recovery of flanged pipes, the flanges, bolts and gaskets should be removed carefully. They should be cleaned immediately and, if it is probable that they will be stored for some time, they should be given a coat of preservative oil or paint. In recovering pipe with screwed couplings, it is often found that the couplings cannot be broken loose. In such cases the pipe should be cut off as close to the coupling as possible and rethreaded, thus preserving almost the entire original length of the pipe.

In the salvaging of lumber and other materials, care should be taken to reduce breakage to a minimum. All nails and bolts should be removed as soon as possible. If the timber recovered has been treated with creosote or other preservative, all bolt and spike holes—especially those which do not extend through the entire timber—should be plugged with creosoted plugs. All split and decayed sections of recovered timber should be removed immediately. Dirt and other

covered valves are often in need of repair before they can be returned to further use. It is important that this rehabilitation work be done as quickly as possible after the materials are salvaged. This will make the materials available for emergency use and thus avoid the use of new materials, either from stock or purchase. Also, if such salvaged material is allowed to remain as recovered for a considerable length of time, the use for which it is intended may be lost sight of and it is likely to be kicked around and eventually reach the scrap pile instead of being used to better purpose.

Of equal importance with the salvaging and rehabilitation of materials is their care after those processes have taken place. Foremen and others in charge of materials should be taught, especially at this time, to give equal thought and effort to the care of usable material as they do to the care of new material. Usable lumber, where possible—especially if untreated—should be stored under cover. If it is necessary to store it outside, provision for the circulation of air should be the same as in the storing of new lumber. Usable steel, after having been cleaned and painted, should be placed on blocking above the ground and care should be taken so that it does not come in contact with cinders, dirt or

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Discussion

A. Chinn (Alton) said that he was particularly impressed by the statement in the report that under present conditions materials must be salvaged because of scarcity rather than for the sake of economy. "Up to now," he said, "we have habitually figured how much we were saving in dollars and cents through the recovery and salvage of materials, but today we are making our calculations on the basis of the number of units of material, with only incidental consideration of cost." Mr. Chinn illustrated this changed viewpoint by relating that several years ago his road had abandoned a branch line that had a considerable number of cast iron culverts, which were left in place because the cost of recovery would have been more than the value of the material; yet today his forces are back on this line taking out the culverts.

L. D. Garis (C. & N. W.) inquired what latitude should be allowed foremen with respect to departing from standards where structures must be repaired or parts replaced. As a part of this discussion W. A. Huckstep (M.P.) inquired as to what substitutes are available for gutters and downspouts, and Chairman Campbell replied that some buildings have gutters and downspouts that do not need them. Partly in reply to Mr. Garis' inquiry, R. E. Caudle (M.P.) said that it is the policy on his road to keep structures to standard so long as the materials to do so remain available, and then to alter these requirements only to the extent of using second hand materials. For a number of years, Mr. Caudle said, the branch lines on his road have been maintained with the better materials salvaged from the main lines, but from now on it will be necessary to use every scrap of old material that can be salvaged. In connection with the use of second-hand material for strengthening steel bridges, G. S. Crites (B. & O.) emphasized the desirability of securing plans for the work from a steel designer before the material is welded, rather than to leave the application to the ingenuity of the welder.

Before Any Structure Is Dismantled, Study Should Be Made to Determine the Best Method of Removing the Materials with the Least Possible Damage

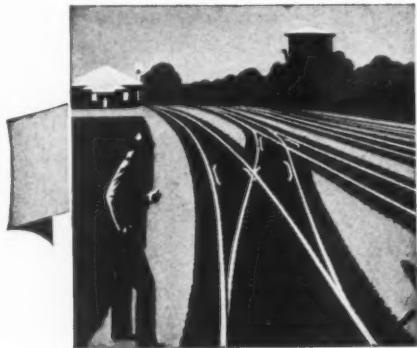


foreign matter should, in so far as possible, be removed immediately from the recovered timber.

Often considerable work of rehabilitation must be done on the recovered materials before they can be reused. The processes which must be used are too numerous for detailed consideration, but are usually obvious. Often bolts which have been recovered have damaged threads. These must be rethreaded and in some cases the damaged threads must be removed, with the result that the reclaimed bolts are somewhat shorter than the original ones. Spikes, bolts and drift pins will often have to be straightened. Re-

other foreign matter. Small hardware should be stored and classified in bins in the same manner as is usually followed with new hardware. A complete inventory of all usable material should, so far as possible, be available at all times, since this is a necessary aid to the most extensive use of usable material in the planning of work.

Committee—F. G. Campbell (chairman), asst. ch. engr., E. J. & E., Joliet, Ill.; M. D. Carothers (vice-chairman), div. engr., Alton, Bloomington, Ill.; W. L. Anderson, off. engr., C. & N. W., Chicago; M. L. Bardill, asst. engr., C. M. St. P. & P., Savannah, Ill.; W. H. Begeman, for. b. & b., M. P., Jefferson City, Mo.; H. F.



WHAT'S the Answer?

Conserving Track Spikes

At present when it is increasingly necessary to conserve steel for military uses, to what extent is it practical to straighten and reuse bent spikes in ordinary maintenance? When laying released rails? New rail? To reuse worn spikes?

Same in War or Peace

By A. CHINN
Chief Engineer, Alton, Chicago

Good practice in straightening and reusing bent track spikes is no different in war time from that which should be followed at any other time, but because of the scarcity of metal in war time it may become necessary to follow their reclamation more closely than usual to know that every spike that is reclaimable is salvaged and reused. It is very easy to throw bent spikes on the scrap pile and then forget about them.

A bent spike that has been straightened properly and which has a full head and shank, is good for any use where a spike, new or second hand, is needed, and it should be so used. If it has lost section through corrosion or wear, it should be classified as reusable or scrap, according to its condition. Some judgment will be required to sort out those spikes that are not fit for further use and are, therefore, definitely scrap. Those that are to be straightened and reclaimed should be sorted and classified for use according to their condition. Those that have not lost section in the head or shank can be marked first grade and reused for any purpose. Those that have lost some, but not too much section, may be marked second grade and used in yards and back tracks. Those that have lost considerable section, especially throat-cut spikes, but still have a fairly good head, may be marked or classified as third grade and used as tie-plate hold-down spikes.

It is poor economy to salvage and straighten these spikes by section or extra gangs in the field. They are not equipped for such work and the men in them are too busy with other tasks to take time out to do it. All spikes not immediately reusable, should be sent to the stores department reclamation plant where they can be sorted and reclaimed in accordance with some systematic and effective plan.

Not in the Field

By F. H. MCKENNEY
District Engineer Maintenance, Chicago,
Burlington & Quincy, Omaha, Neb.

Ordinarily it is not practical to do much spike straightening in the field. All good spikes should be reused in ordinary maintenance, and those that are badly bent, cut or otherwise damaged, should go to the reclamation plant for sorting and straightening, to be sent out as second-hand spikes for branch-line use.

When laying released rail, it is the usual practice to use up to 50 per cent of second-hand spikes, placing the new spikes on the gage side of the rail and the old spikes on the outside. None but full-section straight spikes

To Be Answered in January

1. In view of the extreme demand for cars, what measures can be taken to insure the prompt release of revenue cars containing company material? Of specially assigned cars?

2. In view of the record traffic now being handled, and considering its importance, what precautions should be taken to prevent failure of coaling plants that are not considered necessary under normal operations? Who should look after this?

3. What are the most common causes of failure of power machines and tools? What can be done to prevent them?

4. Is it desirable to make changes in present bridge-inspection practices for the duration of the war? Why? What changes? Are there disadvantages?

5. To what extent should considerations of economy now be ignored in the reclamation and recovery of materials for reuse? What materials? Why?

6. In view of the restrictions on highway vehicles and the increasing lack of suitable train schedules, what methods can be employed to get repair men to water stations in cases of emergency? To transport men and materials in routine maintenance?

7. In what ways can the life of switch points be extended? What precautions should be observed? What are the advantages? The disadvantages?

8. What characteristics of paint will insure the more economical use of both paint and labor?

Send your answers to any of the questions to the What's the Answer Editor. He will welcome also any questions you wish to have discussed.

should be reused when laying released rail in main-line tracks, and any worn spikes that are reusable should be saved for light-service yard and industrial tracks. Badly cut or corroded spikes should be scrapped.

New spikes should be used when laying new rail and the second-hand spikes should be released for branch lines and secondary tracks. Where new rail is laid by mechanized steel gangs, the spikes are usually pulled by mechanical spike pullers, so that no spikes are bent in the pulling, which simplifies the recovery of usable spikes. It is possible frequently to ship the salvaged spikes directly from the rail-laying work to the branch lines where they are to be used, since the minimum of straightening and sorting is required.

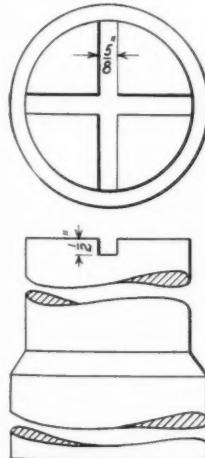
It is our usual practice to send the spikes to the reclamation plant for sorting, however. From here they are sent to the storehouses for distribution on second-hand-spike orders. In this way it is possible to make systematic salvage of all spikes suitable for reuse, and to assure prompt movement of scrap to the market to fill war needs.

Saves 75 Per Cent

By R. L. Fox

Roadmaster, Southern, Alexandria, Va.

When laying new rail of heavier section than that replaced, all spikes must be pulled and on most roads it has been the practice to use all new



A Block Made from a Locomotive Main Driver Pin Is Used for Straightening Bent Spikes

spikes. Then when the released rail is picked up, the old spikes are loaded and sent to the district scrap yard for sorting. The straight spikes are then retained for further use and the bent ones are sold for scrap. This has resulted in scrapping at least 75 per cent of the spikes released during the laying of the rail, while only 25 per cent were salvaged for use on branch lines or in yard and industrial tracks.

Three years ago we began to anchor-spike our joint plates on tangents and to anchor-spike all tie plates on curves of 2 deg. or sharper and have

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used salvaged spikes for anchor spiking. The 25 per cent we were salvaging did not provide enough spikes for this purpose, so we began to straighten the bent ones. For this purpose we use an engine main-driver pin as an anvil, in which a cross is slotted to fit a spike, as shown in the illustration. A pair of tongs was also made for holding the spike head. The spike is placed in the slot and is then struck by an 8-lb. hammer. The spike is held in the slot as it is straightened, so that it does not fly around as it does

when it is placed on a plane surface.

We are obtaining such good results from this method that we are now shipping all of our old spikes to one point on the division, where they are unloaded. On rainy days the yard foreman assigns two men to straighten spikes, with the result that we have reversed the former results and are now salvaging 75 per cent of all spikes, and are scrapping only 25 per cent. The cost per keg of 320 spikes in a lot of 100 kegs reclaimed was \$0.48, not including supervision.

If Air Raids Come

In areas subject to possible air raids and disruption of traffic at several points simultaneously, is it desirable to decentralize material stocks and work equipment? To what extent? Are there any disadvantages?

Large Accumulation Unwise

By E. M. HASTINGS

Chief Engineer, Richmond, Fredericksburg & Potomac, Richmond, Va.

The determination whether material stocks and work equipment that may be required for immediate use following air raids and bombings, should be decentralized should depend on the characteristics and magnitude of the railway facility which is especially vulnerable in the area that may be subjected to air raid. Where air raids are to be expected, the accumulation of large stocks of materials at one point would appear to be unwise, unless the point of centralization is removed a considerable distance from the vulnerable area. However, the farther the centralization point is from this area, the greater will be the delay in getting critical materials and equipment to this point when it will be most needed. Where facilities for a considerable mileage lie in the area subject to air raid and bombing, work equipment and stocks should be well scattered or spaced along the line where, in the judgment of the supervising officers, the hazard is least.

and other catastrophes which fall outside the ordinary maintenance and renewals of tracks and structures, but which maintenance men know are likely to happen from time to time. In the territory covering the slopes of the Allegheny divide and in the seaboard territory subject to storms from the ocean, precautions have been worked out carefully for years, and protection against air raids can follow very nearly the same lines.

It has never been desirable to concentrate flood-protection material and equipment at one point. The reason for this is obvious, for the work of restoring the track would have to be done from one end of the break, that is, pile-driver gangs, grading equipment, track laying and other operations involved in the restoration can proceed with only half the speed that they could if material and equipment were available from both ends.

In this territory we, therefore, are merely following our flood-protection system and keeping our emergency materials in the same places, that is, one set at the extreme east or seaboard end, and others at the next two division points to the west. Ordinarily, pile-driver equipment works in about the same way, and is, therefore, spaced similarly. More attention is given now than in normal times to insure that it is not bunched.

Similarly, dock work follows the same lines as bridge work, and material stocks at two places on the seaboard, with marine drivers also at two separated points, seems to afford enough protection that all of the repair material and equipment will not be destroyed, together with the docks they are intended to protect, in air

Similar to Floods

By I. H. SCHRAM

Engineer Maintenance of Way, Erie, Jersey City, N.J.

The question of stocking material and stationing work equipment for protection in case of air raids is quite similar to that of providing protection in case of floods, wrecks, serious fires

raids. This has also been our ordinary form of protection, which has proved its value at times of serious fires.

There is a further type of protection that is not given much attention ordinarily, but which is now being considered, namely, to have available a stock of filling material that can be loaded readily. Ordinarily, cinders stocked during the winter are used for widening banks, ballasting branch lines, protecting cuts and other work during the summer. It has been necessary during the last working season to maintain, without depletion, stocks of filling material in about the same locations as the emergency bridge material, and the arrangement seems to be advantageous. Certainly, there have been no interruptions to traffic or to work by reason of the precautions that have been taken, but they proved as valuable as ever when the floods of May and June, 1942, disrupted a large part of the railway facilities in the drainage areas of the Delaware and Susquehanna rivers.

Draw on Other Experience

By DIVISION ENGINEER

None of us can yet speak from experience, and we earnestly hope that we may never have to do so, but wishful thinking will be of no benefit if air raids do come; we will benefit only as we prepare for them in the light of such information as we can obtain, backed by our experience with storms, floods, fires and other disasters with which we are familiar. While I believe in ample preparation for any eventuality we can foresee, I see no justification in getting jittery about air raids, any more than we do about storms or floods, although we know that in the natural course of events we must cope with them from time to time.

As I see the situation, each road or district must decide for itself, the kind and amount of emergency material to be held in reserve, in the light of the facilities that are most likely to be destroyed. If it is for the protection of docks, long piles and suitable timber and lumber will be called for; if it is expected that a yard, a passenger terminal or an intricate track layout will be bombed, rails, ties, crossings, switches and frogs, and possibly slip switches, should be held in reserve; or it may be bridge, building or water-service material that will be needed to repair this form of destruction. It cannot be expected that all of this material will be needed at any one place or at any one time. I do not consider that it will be good management to concentrate all such

materials at any one point where a single bomb might destroy all of it. On the contrary, even each kind of material should be stored at several points, but where it will be readily available in case of need. The same comment applies to work equipment. It is particularly desirable to have every unit of pile-driver equipment in shape for instant use.

It should not be overlooked that

there are many hundreds of miles of railways in this country, upon which the probability of air raid damage is practically zero. While there are large areas that are quite vulnerable to long-distance air raids, these are mostly metropolitan centers where war industries are concentrated and where more damage can be done to terminal facilities than would be possible with the same effort out on the line.

Conserving Wire Rope

What measures can be taken to conserve the life of wire rope?

Replacements Uncertain

By H. T. LIVINGSTON

Engineer of Bridges, Chicago, Rock Island & Pacific, Chicago

With the replacement of wire rope as uncertain as it is today, conservation of its life becomes a matter of prime importance. Wire rope in storage should be coiled and impregnated with lubricating and preservative material to prevent corrosion during storage. When in service, wire rope should be inspected frequently, especially that on machines that are operated at high speeds. The principal item to be observed is that it is adjusted to run freely and in line over sheaves and drums. The rope and the sheaves should fit, that is, the grooves in the sheaves should be neither too large nor too small, and the rope should wind evenly on and from drums without crossing itself.

Since wire rope is actually in the nature of a machine, in which all parts have relative movement, it must be well lubricated. This is especially important for high-speed operation. A suitable lubricant will also resist corrosion and thus insure that the interior wires of the rope will not fail. Although thoroughly saturated when the rope is made, the hemp center may have almost all of the original lubricant squeezed out when the rope is manufactured, so that little dependence can be placed in this lubricant.

For these reasons the lubricant that is selected for the rope should be able to stand fairly high temperatures without becoming so fluid that it will become lost or ineffective. Neither should it be so viscous that it will not penetrate to the inner wires or become hard and flake off the outside of the rope when exposed.

Operators of machines must watch the rope in operation to see that kinks do not occur. This is more likely to

happen when the rope becomes slack. When rope is installed originally on a machine or in a structure it should be uncoiled or run off on a drum or a reel in a straight line. When slack is taken up, the rope must be observed for kinks, which must be removed before even a light strain is placed upon it. Operators should also examine rope sheaves and drums at the beginning of each work period. Sudden strains should be avoided. Ropes, sheaves, drums, snatch blocks and other parts that come in contact with the rope should be kept free from dirt and grit. When more than one layer of rope is necessary on a drum, succeeding layers should lie in the grooves in the layer next below.

It might be well for operators and others using or responsible for the use of wire rope to secure from responsible manufacturers all of the information that they make available on the proper practices in handling it and then observe these instructions.

Should Go to Extremes

By C. L. FERO

Supervisor of Work Equipment, Boston & Maine, Boston, Mass.

It is becoming more important day by day that the life of wire rope be preserved. We have all experienced difficulty in obtaining new wire rope and, with the understanding that procurement is to be even more difficult, I believe that we are warranted in going to extremes in the care that is taken of the supply we are now using or have available.

It is specially important to keep the rope well lubricated, using a lubricant with a good body. This will act to prevent rust and corrosion of the surfaces exposed to the atmosphere, reduce the friction between the strands when in use and adds greater life

where the rope moves over sheaves. A study of the work to be performed and the most suitable type of wire rope to be used will also result in longer life and better production results.

Along with close inspection of the sheaves while in operation to ascertain when the groove starts to wear and ridges begin to appear, the proper groove size for the cable to be used and the correct sheave diameter are equally important. The correct lay of the cable should be given consideration to allow for proper winding on the drum and, so far as possible, only enough cable should be used to fill the drum one layer deep.

The operator should be educated with respect to the care and use of the rope, since a new cable may be spoiled within a few minutes through carelessness when applying it or during

Railway Engineering and Maintenance

operation, and instruction in the care, operation and maintenance of the rope pays large dividends in cable life. Cables should be watched for wear and when wear is noticed near the ends, a small section of the cable should be cut off. When cut to the minimum length that can be used, further life may be obtained by reversing the cable and using the end that was on the drum for the hook or the bucket-closing line.

When cables are used in connection with shackles or eyes, or are connected to an appliance where there is likely to be a sharp bend, the use of thimbles will prevent wear at the point of contact and prevent the spreading of the cable, chafing or the breaking of the inner strands. Care must be exercised to have the cable tight around the thimble, however.

With this knowledge he must then exercise his best judgment as to whether the defects are of such a nature as will endanger the safety of the employee or of others. Many of the defects which made applicants undesirable during periods when labor was plentiful, and when only the most nearly perfect men were selected, can and must now be overlooked if the necessary men are to be obtained.

The only disadvantage that will result from increasing the age limit might be a slight reduction in the volume of work which such men can turn out. This reduction will increase as the men grow older. The disadvantage of hiring men with physical defects which previously have barred them, may also result in a reduction in the volume of work performed, but if proper judgment is exercised in employing them, there should be little danger of accidents or deaths.

If older men and those less physically perfect continue in the service for any length of time they will accumulate seniority, and it may be difficult to remove them when more efficient men are available later on. However, the present conditions must be met and the future will have to take care of itself as best it can.

Shall Requirements Be Relaxed?

In view of the drain that military service and industry are making on the maintenance forces, is it now desirable to raise the age limit or relax the requirements for physical examinations, or both, for section and extra-gang labor? To what extent? What are the disadvantages?

Considers It Necessary

By F. R. LAYNG

Chief Engineer, Bessemer & Lake Erie,
Greenville, Pa.

Owing to the heavy drain that military service and war industries are making on the maintenance forces, it is not only desirable but absolutely necessary that every means possible be taken to secure the men necessary for maintenance work. Military service is taking a large percentage of these forces, as many of them are within the draft age and have no dependents. In the past, most of the new employees were recruited from among such men. This situation, together with the number that are going into war industries because of higher wages, has resulted in a depletion of the maintenance forces to such an extent that under-maintenance is beginning to accumulate. This situation becomes more critical as the volume of traffic increases.

To secure the needed employees, the age limit must be raised. If the age limit is now 45 years, raising it to 50 or 55 years will enable the railways to obtain an appreciable number of able-bodied men. If only men under 45 years of age are employed, many of them will be drafted or will resign and there will be a constant turnover in the force. Each new employee must

receive some training before he can perform properly the work to which he is assigned. For this reason, the greater the turnover in the force the greater will be the inefficiency of labor, and also the greater will be the risk of injury because of the employees' lack of familiarity with the work.

Increased use of work equipment has reduced the physical effort required of track labor. Older men can operate this equipment as well as the younger men, and in many cases they are more settled than younger men, especially those of legal minimum employment age.

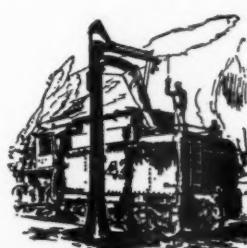
Relaxing the physical requirements will also make more competent men available. Before being hired, every prospective employee should have a rigid physical examination. The employing officer should have complete knowledge of the applicant's physical condition and of all physical defects.

End Makes It Necessary

By L. G. MOSHER

Personnel Assistant, Maintenance of Way,
New York, Chicago & St. Louis, Cleveland, Ohio

In itself, raising the age limits for section and extra-gang labor may not be desirable, but the end that it is sought to accomplish makes it not only desirable but absolutely necessary. Maintenance officers have one job that is essential to the war effort and that is to keep the track and roadbed in shape to "keep 'em rolling." The present shortage of maintenance of way labor and the necessity for training men quickly and thoroughly is emphasized in current editorials and articles in *Railway Engineering and Maintenance*, but maintenance officers know that neither educational programs nor untiring supervision will in themselves install ties, ballast or rail, or perform other work. They also know that they cannot retain in service men who are fit physically, are of draft age and are without dependents. Neither can they attract men of the same age who are draft-exempt, from other fields where higher wages prevail. The only feasible way in which they can replace men who join the armed forces or who leave railway service for other reasons, is to expand the age limits and relax any un-



necessarily restrictive physical requirements.

Obviously, present age limits were not designed for this emergency. It is equally obvious that the proper course is to relax fully the present age limits for the duration, and to relax also any minor physical requirements. By doing this the field officer will be able to employ men who can perform the work and maintain the railway. At this time the exact age is unimportant, while ability to perform the work is all-important. In time of stress, the field judgment of experienced officers is worth much more than arbitrary rules. For this reason,

I think that we can safely allow the roadmaster or supervisor to judge the extent to which it is necessary to relax the rules in his territory, to insure the necessary supply of labor.

Increased safety hazards, the necessity for closer supervision, the future loss of efficiency, the breaking down of standards established in normal times and many other incidental results of these relaxations are very real disadvantages, but they are greatly outweighed by the necessity for having sufficient labor to maintain the railways to standards that insure uninterrupted operation—not at some time in the future, but right now.

an alert, whether it is the real thing or only for practice. Beams projected below the horizontal are not visible from planes, but if the light is of much intensity the area it illuminates may be seen. It is for this reason that switch and signal lights are hooded.

The second fact to be remembered is that we can get along with a surprisingly small amount of light when necessary. Persons with normal eyesight can get around easily on a clear starlight night; yet the total light available is only a small fraction of a candle power. If we increase our lighting to as much as 10, 20 or even 30 times this intensity, we can get around safely, although we may not be able to do all the things we can do under better illumination, and still not allow any light to show to an approaching plane.

Offices, such as those for dispatchers, telephone operators and telegraphers, where night forces must continue their employment during the alert, must have some arrangements for covering windows and other openings through which light might escape. If doors must be opened during the emergency, they should be provided with both inside and outside vestibules, to insure against the escape of light from the building, with only enough light of the dispersed type in each vestibule to give the minimum illumination needed.

Engine houses, machine shops, power houses and other buildings having large window areas present a difficult problem which cannot be solved very well by coverings for the windows and skylights, although this may be practical in some cases. Certain types of lamps have the approval of the army for use where illumination is essential during the blackout period, provided they are used in accordance with instructions, which include hooding, and investigation should be made to determine whether these lamps can be used in specific cases where uninterrupted service is essential.

So far as practical, passenger stations and platforms should be without illumination during the blackout period. Where it is necessary to maintain service, however, illumination should be reduced to the minimum consistent with safety; the lamps should be shrouded and of the type already mentioned, with good dispersal characteristics which give no reflection from any part of the area illuminated.

Where windows must be covered or vestibules provided, the provisions for doing this should be made by the building department forces. If changes are necessary in the wiring, the outlets or other illuminating equipment, they should be made by

Preparing for Blackouts

What preparations should be made for blacking out buildings that must be occupied by night forces? Who should do this? Who should be responsible for making the blackout operative when the need arises?

Dim the Lights

By O. G. WILBUR

Appraisal Engineer, Baltimore & Ohio,
Baltimore, Md.

Pending war-department regulations, which at present are in the formative stage, pertaining to the blacking out of railway buildings under either test blackouts or alert signals in actual emergencies, passenger station lighting should be reduced to the minimum required for safe operation. Vestibule and entrance lights should be extinguished or cut down in intensity and so hooded as to reduce to the minimum the showing of light outside. Platform lights should also be reduced to the minimum and should be so hooded as to prevent the upward projection of light.

Small suburban stations should be blacked out completely by extinguishing all lights, both in the buildings and on the platforms, except stations that handle a large volume of traffic at certain times, such as commuter traffic, during which time the station lighting should be reduced to the minimum required for safe operation.

Buildings used strictly for office purposes should be blacked out completely, with essential offices treated to effect the proper result. The lighting of interlocking towers should be reduced to the minimum, and such lights as are necessary should be of low intensity and so hooded as to project the light downward only.

In engine houses and shops, at coaling plants, water stations, ash pits and crossing-gate houses, all lights should

be extinguished, except in blackout-treated rooms or sections. Essential employees who are required to work during a blackout should do so by the aid of low intensity flashlights showing a white light. All flood lights should be extinguished and docks and wharves should be blacked out completely by extinguishing all lights.

Local operating forces should be made responsible for the preparations necessary to meet blackout requirements and the local operating organizations should be charged with making the blackout operative. Specific employees should be assigned to specific duties, with two alternates, if this is practical, for each assignment. Then each one of this trio should be responsible for the carrying out of this duty in the absence of the other two men. Where state regulations have been adopted, it will be necessary to comply with them until such time as federal standards are issued.

Keep Two Facts in Mind

By GENERAL INSPECTOR OF BUILDINGS

Two facts should be kept in mind in connection with blackouts. The first is that any light that is projected upward, whether this be vertically or at any angle above the horizontal, can be seen from an airplane, and it does not need to be of very much candle power to be visible. Horizontal beams can also be seen as the plane approaches the source of light. It is for this reason that windows should be closed with opaque curtains or panels during

the electrical department, which should also provide the special lamps and the hooding. The operation of these facilities should then be the responsibility of the forces that occupy

the buildings. The supervising units for these forces should make whatever other arrangements are necessary and assign the occupants to such duties as must be performed.

Substitutes for Bristles

In view of the supply of bristles being shut off, what substitutes can be employed for paint brushes? To what extent are they satisfactory?

No Substitute

By A. T. HAWK
Engineer Architect, Chicago, Rock Island & Pacific, Chicago

Heretofore, paint brushes have been made almost universally of hog or boar bristles, obtained mainly from countries now at war, for which reason the supply is now shut off. There seems to be no satisfactory substitute for the hog bristle. Intense study has been made and is still in progress, and out of the investigation some substitutes have been developed, such as the use of nylon, but still further study will be needed before the old hog bristle can be replaced satisfactorily. Horse hair is being used to some extent, but the results have not been entirely satisfactory.

Probably, we will have to rely principally on spray painting. After a painter becomes expert in the use of the paint spray he can do practically as good a job as with a brush and at much less cost. While spraying does waste paint, labor is saved, and spraying will cover better those areas it is difficult or impossible to reach with a brush and thus do a better job.

Cannot Replace

By GENERAL INSPECTOR OF BUILDINGS

Hog bristles are particularly suited for paint brushes, primarily because they taper, although length and resilience are important characteristics. Domestic hogs produce tapering bristles, but they are too short to be of practical use. Horse hair and nylon have been tried as substitutes, but neither of them taper and neither have the resilience or "spring" that characterizes a first-class paint brush. While these materials can be used, they do not spread the paint evenly or "feed" it at the correct rate, because they do not taper but are of uniform diameter throughout their length. In other words the brushes that have appeared so far will paint but they do not

even approach the perfection of the bristle brush.

In this situation the best recourse is to utilize a tool that has already

made some headway in railway painting. I refer to paint-spraying equipment. In many fields spray painting has pushed brush painting into the background or has eliminated it, but it has not been so popular among bridge and building men, although some of us have looked upon it with favor for a number of years and advocate its use.

Spray painting requires less labor than brush painting for equal areas and similar surfaces. When a painter once acquires the necessary skill he will do as satisfactory a job with a paint spray as with a brush, and the paint will last as long. This method will solve the brush problem, except for a few special painting jobs, such as striping and edging.

Standardizing Tie Plates

What advantages are there in standardizing tie plates for each width of rail base, for the duration of the war? After the war is over? Are there disadvantages?

Favors Less Designs

By DISTRICT ENGINEER

Any action that tends toward a reduction in the number of tie-plate designs should be of benefit to the manufacturer and the railways alike. The activities of the Track committee of the A.R.E.A. and of its subcommittee on tie plates during the last several years have been commendable and, I believe, should have desirable results. In the natural course of events, however, the influence of the work of this subcommittee on tie-plate design, even though backed by a committee as strong as that on Track, would have developed slowly. It may be that the present situation will give it the impetus it should have and that the desired results will now be attained in much less time.

I am in hearty accord with the action of the A.R.E.A. in recommending an arbitrary reduction in the number of designs for tie plates for 112-lb. and 131-lb. rail, to two for each section. Obviously, however, there will be no point in preventing the use of rolls now on hand for other designs until they are worn out; in fact, it will be of benefit to allow them to be used, for this will eventually get them out of the roll-storage area, where they always present a problem to the manufacturer. The 90-lb. and 100-lb. rail sections are so nearly obsolete, so far as new rollings are concerned, that there should be less point in prescribing restrictions on the use of existing tie-

plate rolls for these sections, since so few are being ordered currently.

It is to be hoped that the present limitation on the number of designs for tie plates, or something along the same line, will be continued after we return to normal. While no specific mention is made of the punchings to be used with the designs recommended for the duration, the freezing of the punchings is implied in the circular issued by the A.R.E.A. It is to be hoped that this will be the immediate as well as the ultimate result. To my mind there is less justification for the great variety of punchings for tie plates than for any other item in the designs for track materials, unless it is the punchings for joint bars. Variations in the punchings of tie plates affect the manufacturer unfavorably, but they have wider ramifications; for they often affect the tie producer adversely and prevent him from treating his unsold ties when they have seasoned and are ready for treatment.

We are in the midst of an emergency and it is obvious that some action was necessary to relieve manufacturers of a burden that they should not have been required to bear, especially under present conditions. It is encouraging to know, however, that action went so vigorously and so directly to the heart of a situation that should not have persisted for so long, that is, the great multiplicity of designs that the railways have insisted on. While there has been an improvement in this respect in recent years, the movement toward a reduction in

the number of tie-plate designs had not gone as far as it should, and certainly this is more than true with respect to punchings.

Normally Eight Sizes

By C. W. BREED

Office Engineer, Chicago, Burlington & Quincy, Chicago

For normal practice the American Railway Engineering Association recommends the use of eight sizes of plates as follows:

(1A) 10 in. long and (1B) 10½ in. long, for 90-lb. RA rail; (1C) 10½ in. long, and (2) 11 in. long, for 100 and 112-lb. RE rail; (3) 12 in. long, for 131-lb. rail; (4) 12 in. long, for 112-lb. rail; (5) 13 in. long, for 131-lb. rail; and (6) 14 in. long, for 131-lb. rail. It will be noted that there are at least two lengths of plates for each weight of rail.

There are several advantages in this standardization. Previously there were a great many rolls for the manufacturing of tie plates, differing only slightly. Standardization reduced the number to eight. There are sufficient sizes for each weight of rail in this list to give ample latitude for making a selection for light or heavy traffic; also for use on either hardwood or softwood ties.

To ease the tie-plate manufacturing situation for the duration of the war, particularly in an effort to reduce the number of rolls required to produce tie plates, the emergency committee of the Board of Direction of the A.R.E.A., has recommended that the length of tie plates be limited to either 12 in. or 14 in. for 131-lb. rail and to 11 in. or 13 in. for 112-lb. rail. They will not come into general use, however, until the existing rolls for other designs of tie plates for 112-lb. and 113-lb. rails are no longer available. A comparatively small number of tie plates are needed for rails weighing 100 lb. or less per yard, for which the manufacturers have rolls, and these are to be continued unless their production interferes with the war effort, in which case it is recommended that alternate designs be substituted.

In view of the tendency for an increasing number of roads to use tie plates with flat bottoms, the emergency committee recommended that all plates have flat bottoms—that is, without ribs. Railroads that have been using ribbed plates for the purpose of holding gage with only two spikes will now have to use flat-bottom plates and add two anchor or hold-down spikes, which will assure the holding of the gage.

After the war is over we should, without doubt, return to the greater

selection of designs shown in the A.R.E.A. Manual, which are all included in the foregoing list, except the 10½-in. plate for 112-lb. rail, which has declined in use and will probably disappear, so that either the 11-in. or

13-in. length will be the recommended standard. This will be an advantage, in that there will be an 11-in. plate for use with hardwood ties and a 13-in. plate for softwoods, as well as a selection for light and heavy traffic.

Substitutes for Rubber Gaskets

In view of the present shortage of rubber, what other materials can be used for gaskets? What considerations are involved?

Comprise Four Groups

By K. J. WEIR

Special Water Inspector, Chicago, Milwaukee, St. Paul & Pacific, Chicago

Gaskets for water service facilities may be classified in four general groups—(1) hose lines, (2) plumbing fixtures, (3) pipe lines and (4) water columns and tank outlet valves. Prior to the present emergency rubber was used almost universally as gasket material, but within recent months several organizations have reported on recommended rubber substitutes. Leather is a suitable substitute for hose-line gaskets, except for lines carrying acids. It has been found practical to eliminate the usual hose connections, replacing them with pipe nipples and unions for certain installations. The varied types of gaskets used in plumbing fixtures prevent the development of a universal substitute for rubber. While leather and plastics can be utilized in some instances, in general, gaskets of reduced rubber content will be found most suitable.

Many substitute materials are available for pipe work. They include roofing papers, plywood, sheet asbestos, sheet lead, felt, impregnated vegetable fibre and white lead on canvas, as well as some others. Threaded joints and welded pipe lines deserve consideration if substitute gasket materials are found impracticable. Careful salvage of old gaskets during dismantling operations should prevent their destruction and provide for their reuse. These same materials can be substituted for certain gaskets for water columns. However, both the water columns and the tank outlet

valves require a number of molded rubbers for which no suitable substitutes have yet been developed.

Must Conserve Rubber

By SUPERVISOR OF WATER SERVICE

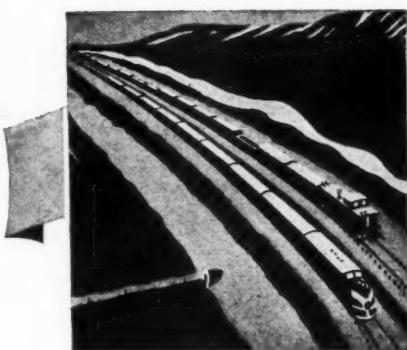
Rubber is not only one of the most critical war-time materials, it is the rarest of the materials commonly used in railway water service. Pipe, plumbing fixtures and other metal items may be difficult to obtain at present, but the country possesses ample raw materials (ores) to meet all needs, the present shortage of these materials being the result of the priority given to military industries. It is not so with rubber, for we possess none of the raw material and when our present stock is gone we are through, unless we are prepared to manufacture synthetic rubber.

Rubber gaskets are not suitable for hot-water and steam lines. For cold-water lines, ordinary roofing paper, roofing felt, leather, asbestos sheets, plywood or even canvass or heavy muslin coated with white lead can be used to good advantage as substitutes for rubber where gaskets are needed. The use of welded pipe lines will reduce the number of gaskets that will be needed. Leather gaskets are also satisfactory for hose lines and for certain plumbing fixtures.

In plumbing equipment, however, the requirements are so varied that no single material will meet all requirements, and in some cases no substitute has yet been satisfactory. In the latter case it is best to use prefabricated gaskets of reduced rubber content, provided they can be obtained.

Water columns present a problem with respect to substitutes for they require that certain of the gaskets be molded, which the manufacturers contend can be done only with rubber. Substantially the same situation exists with respect to tank outlet valves, except that they do not require as much rubber as the water columns do.





NEWS of the Month

Railway Operating Revenues at All-Time High

Railroad operating revenues for the first eight months of this year have already exceeded those for the entire calendar year 1940, and are 9.9 per cent above the peak year 1929, the Interstate Commerce Commission's Bureau of Transport Economics and Statistics noted in the latest issue of its Monthly Comment on Transportation Statistics. The increase, as compared with 1929, is due to the 17.5 per cent rise in freight revenues which more than offset the 1.3 per cent drop in passenger revenues, and lower mail revenues.

Pullman Sets Troop-Handling Record

All previous records were broken in September when the Pullman Company moved 835,000 troops in its sleeping cars, compared with the previous peak of 750,000 set in August. In the first nine months of this year, the Pullman Company has handled 5,185,000 men in troop movements.

"The increasing heavy demand for sleeping cars for moving troops has sharply reduced the number of Pullmans available for civilian use," G. A. Crawford, president of the company, stated at a meeting of the Board of Directors at Chicago on October 22. "The needs of the armed forces come first and consequently every sleeper is potentially a troop car."

"The co-operation of civilian travelers can be very helpful. They will find that by planning trips well in advance with the transportation agencies, accepting available accommodations, and traveling light they will experience less inconvenience than they had anticipated under the travel conditions existing today."

U. S. Army Leases Yukon Railroad

Brig. Gen. Carl R. Gray, Jr., general manager, Military Railway Service, announced on October 19 that construction of the new military highway to Alaska is expected to be completed by December 1, and that the United States Army has leased 111 miles of the White Pass & Yukon line, from Skagway, Alaska, to Whitehorse, Yukon Territory, thus providing a rail connection between the Alaskan coast and the northern terminal of the military highway. General Gray said that temperatures as low as 72 deg. F. and virtually continual gales of 35 miles an

hour add to operating difficulties on this line which is already functioning under the direction of Brig. Gen. J. E. Ausland, C. E., with technical supervision under the direction of General Gray, who negotiated the lease for the War Department. The entire project is under the jurisdiction of the Northwest Service Command, of which Brig. Gen. James A. O'Connor is commanding general.

Must Have New Cars and Locomotives

That rail transportation is approaching a critical stage wherein new locomotives and cars must be furnished if the railroads are to handle the peak traffic expected in the coming months, was indicated by John J. Pelley, president of the Association of American Railroads, and Joseph B. Eastman, director of the Office of Defense Transportation at the annual meeting of the National Association of Shippers Advisory Boards at Chicago on October 16. "When it comes to taking in slack, the shippers and railroads have done so well that we are pretty close to the end of the rope and there is a clear and definite need for new locomotives and new freight cars," Mr. Eastman said. "The railroads are close to the bottom of the barrel in their efforts to increase utilization of their present equipment, particularly their motive power and there is no further margin left in the reserves represented by unserviceable and surplus equipment," Mr. Pelley warned.

"It goes without saying," Mr. Eastman said, "that if we are to attain and maintain maximum utilization of existing facilities, they must be kept in prime order and repair, and this is true, not only of the locomotives and cars, but also of the roadbed and track, including most emphatically the steel rails. I have so reported to the War Production Board. I sympathize with the position of the Board that the utmost possible work must be got from existing facilities and that the amount of work to be done must be brought within the lowest limits that are practicable and wise, but with the present and prospective demands upon the transportation facilities of the nation, and particularly upon the railroads, such efforts cannot remove the need for necessary replacements or even the need for some degree of expansion. It is also clear, as I see it, that our carriers cannot properly be included in the category of civilian supplies, for there is nothing which is so intimately and pervasively related to

the entire war effort as transportation.

"No one knows for sure what the future will bring forth, but it is certain that the railroads are driving their cars and locomotives as they have never been driven before and that they have very little strength in reserve. The productive effort of the country has not reached its peak, and I have no reason to believe that the traffic volume has reached its peak, or will for some time to come."

Mr. Pelley announced that the railroads have asked the proper government agencies for authority to obtain 80,000 new freight cars, approximately 900 new locomotives, 2,100,000 tons of new rails and adequate maintenance materials for the year ending October 1, 1943. "If that program is fulfilled," he added, "the country may look for a continuation of satisfactory railroad freight operating performance. Even if that number of locomotives is authorized, built and placed in active service before next October, it will be necessary for each locomotive in active service to turn out 7 per cent more ton-miles of work in October, 1943, than in the current month."

WPB Organizes New Transport Division

The War Production Board has created a new Division of Stockpiling and Transportation, consolidating the staff and functions of that agency's former Transportation Committee and its Stockpile and Shipping Imports Branch. This division "has the authority to work out systems of transportation priorities, if it becomes necessary to do so." Dr. W. Y. Elliott, former chief of the Stockpile and Shipping Imports Branch, will be director of the division, and A. F. Shafter, former chairman of the WPB Transportation Committee, will be director in charge of transportation and storage.

The principal objectives of the new division, according to the WPB announcement, are: (1) To make determinations with respect to transportation needs for the movement of commodities and materials essential to the war effort; (2) to establish schedules of priorities of movement in transportation of commodities and materials; (3) to insure through appropriate action that essential materials are imported for consumption and stockpiling; (4) to guide other government agencies with respect to the most effective use of warehouse facilities; and (5) to promote the safety of stocks of critical and strategic materials in storage.

Personal Mention

General

D. M. Dunlop, roadmaster on the Canadian Pacific at Ignace, Ont., has been promoted to assistant superintendent, with headquarters at Kenora, Ont.

C. E. Smith, office engineer of the Wheeling & Lake Erie, has been appointed industrial agent, with headquarters as before at Cleveland, Ohio.

J. W. Purdy, division engineer maintenance of way on the Baltimore & Ohio at Akron, Ohio, has been appointed assistant superintendent of the Akron-Chicago division.

Boynton S. Voorhees, engineering assistant to the vice-president of the New York Central system, has been appointed assistant vice-president, with headquarters as before at New York. Mr. Voorhees was born at Hackensack, N.J., on April 29, 1886, and graduated from Sheffield Scientific School, Yale University in 1907. He entered railroad service in 1907 with the New York, New Haven & Hartford, serving successively as a rodman and inspector in the maintenance of way department. From 1908 to 1912 Mr. Voorhees served successively as a rodman, instrumentman and inspector in the construction department of the New York Central and in the latter year he became assistant engineer of grade crossings. He was promoted to engineer of grade crossings in 1916 and in 1920 he became district engineer, Eastern division. Later in 1920 Mr. Voorhees



Boynton S. Voorhees

was appointed general office engineer of the New York Central system, which position he held until 1924, when he became engineering assistant to vice-president, improvements and development.

Charles G. Stewart, assistant chief engineer of the Pittsburgh & Lake Erie, has been promoted to general manager, with headquarters at Pittsburgh, Pa. Mr. Stewart was born on November 27, 1885, at Hockingport, Ohio, and graduated from Cornell University in 1912. He entered railroad service on October 1, 1912, as an assistant on the engineering corps of the

Railway Engineering and Maintenance

Pennsylvania at Cleveland, Ohio. From November, 1916, to March, 1923, Mr. Stewart was employed by the Baltimore & Ohio, serving successively as assistant supervisor at Walkerton, Ind., assistant district engineer at Cincinnati, Ohio, and assistant division engineer at Flora, Ill., and Washington, Ind. He was engineer maintenance of buildings for the Jones & Laughlin Steel Corporation at its South Side Works, Pittsburgh, Pa., from March, 1923, to April, 1925, and from the latter date to January, 1927, he was identified



Charles G. Stewart

with the real estate business. In January, 1927, Mr. Stewart was appointed engineering draftsman for the Pittsburgh & Lake Erie at Pittsburgh, and served in this capacity until December 1, 1940, when he became assistant chief engineer.

H. D. Kruggel, passenger trainmaster of the Middle division of the Pennsylvania, and an engineer by training and experience, has been promoted to superintendent of the Monongahela division, with headquarters at Pittsburgh, Pa. Mr. Kruggel was born in Ohio on February 17, 1903, and entered the service of the Pennsylvania on June 4, 1922, as a machinist helper, leaving the service on June 10, 1922. He returned to the Pennsylvania on June 20, 1927, as an assistant on the engineer corps of the New York division, becoming assistant supervisor of the Williamsport division on June 20, 1928. Mr. Kruggel was transferred to the Philadelphia division on July 7, 1928, and to the Philadelphia Terminal division on June 1, 1929. He was promoted to supervisor of the Sunbury division on August 1, 1929, and was transferred to the Cumberland division (now part of the Philadelphia division), on February 1, 1931, to the Delmarva division on September 25, 1931, to the Williamsport division on July 24, 1933, and to the Eastern division on February 14, 1934. Mr. Kruggel was appointed assistant trainmaster of the Panhandle division on January 16, 1935, and was later transferred to the Middle division. He was promoted to passenger trainmaster of the Middle division on February 1, 1941.

Engineering

Raymond C. Lowrey, resident engineer of the Missouri & Arkansas, has been appointed engineer maintenance of way,

with headquarters as before at Harrison, Ark., a change of title.

M. H. Doughty, assistant to the chief engineer of the Delaware, Lackawanna & Western, with headquarters at Hoboken, N.J., retired on October 1.

O. G. Wilbur, field engineer in the building department of the Baltimore & Ohio, has been promoted to appraisal engineer on the staff of the chief engineer, with the same headquarters.

L. W. Althof, division engineer on the Union Pacific at Spokane, Wash., has been transferred to Portland, Ore., and **E. F. Kidder** has been appointed division engineer at Spokane, succeeding Mr. Althof.

Rutherford Snell, principal assistant engineer in the office of the transportation engineer of the Chesapeake & Ohio, has been appointed statistician, with headquarters as before at Richmond, Va., succeeding **L. S. Wilbur**, deceased.

J. R. Traylor, assistant engineer on the Missouri Pacific lines at Houston, Tex., has been appointed assistant valuation engineer, with the same headquarters, succeeding **H. T. Bradley**, whose appointment as valuation engineer, with headquarters at St. Louis, Mo., was reported in the August issue.

Rowlette L. Mays, assistant supervisor of bridges and buildings on the Clover Leaf district of the New York, Chicago & St. Louis (Nickel Plate), has been promoted to designing engineer, with headquarters at Cleveland, Ohio, succeeding **Reginald T. Blewitt**, whose promotion to bridge engineer was reported in the October issue.

H. L. Wolridge, roadmaster on the St. Louis-San Francisco at Amory, Miss., has been promoted to division engineer of the Northern division, with headquarters at Ft. Scott, Kan., succeeding **F. N. Beighley**, who has been appointed roadmaster at Kansas City, Mo.

Kenneth L. Clark, assistant engineer on the Chicago, Milwaukee, St. Paul & Pacific at Chicago, has been promoted to division engineer of the Hastings and Dakota division, with headquarters at Aberdeen, S. D., succeeding **William E. Ring**, who has been transferred to the Rocky Mountain division, with headquarters at Butte, Mont., relieving **D. C. Rhynsburger**, assigned to other duties.

W. G. Cowie, supervisor of track on the New York Central at Rochester, N.Y., has been promoted to division engineer of the River division, with headquarters at Weehawken, N.J., succeeding **Ervin J. Bayer**, whose promotion to assistant district engineer on the Michigan Central, with headquarters at Detroit, Mich., was reported in the October issue.

Mr. Cowie was born on November 1, 1890, at Holyoke, Mass., and received his higher education at Rensselaer Polytechnic Institute, graduating in civil engineering. He entered the service of the New York Central on August 15, 1921, as a rodman in the engineering corps, being advanced to transitman soon thereafter. He was further promoted to assistant supervisor of track, with headquarters at Buffalo, N.Y., on February 1, 1928. On July 1, 1939, he became supervisor of

(Continued on page 848)

A

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WHY risk rail end-batter . . . high track maintenance cost and more frequent rail replacements when OLIVER Track Bolts give so much security at so little cost?

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track, with headquarters at Rochester, N. Y., which position he held until his recent promotion to division engineer.

Frank R. Paisley, engineer maintenance of way of the Pittsburgh & Lake Erie, has been promoted to assistant chief engineer, with headquarters as before at Pittsburgh, Pa., succeeding Charles G. Stewart, whose



Frank R. Paisley

promotion to general manager is reported elsewhere in these columns. **John P. Ensign**, supervisor of track of the New York Central at New York, has been appointed engineer maintenance of way of the P. & L. E., replacing Mr. Paisley.

Mr. Paisley was born at Beaver Falls, Pa., on December 29, 1889, and attended Carnegie Institute of Technology. He entered railroad service on August 23, 1911, with the Pittsburgh & Lake Erie, serving successively as chainman, rodman and transitman until October 16, 1922. He was then inspecting engineer and engineering assistant to January 15, 1935, and on the latter date he became engineer maintenance of way at Pittsburgh, which position he held until his recent promotion to assistant chief engineer.

Mr. Ensign was born on June 7, 1898, at Easton, N.Y. He graduated in civil engineering from Union College, Schenectady, N.Y., in 1922, and entered railroad service on May 14, 1923, as a rodman on the Electric division of the New York Central. Mr. Ensign was promoted to assistant supervisor of track on the same division on September 1, 1926, and was promoted to assistant division engineer of the Eastern division, on September 1, 1933. On July 1, 1938, he became assistant engineer track, lines East, and on July 1, 1940, he was appointed supervisor track, Electric division, which position he held until his recent promotion to engineer maintenance of way of the P. & L. E.

Reginald T. Blewitt, whose promotion to bridge engineer of the New York, Chicago & St. Louis (Nickel Plate), with headquarters at Cleveland, Ohio, was reported in the October issue, was born at Barrow-in-Furness, England, on August 11, 1894, and attended Barrow Technical School. He entered railway service on April 1, 1914, as an apprentice civil engineer with the Furness Railway Company (now the London, Midland & Scottish), and three years later he served as an apprentice engineer for five months on 4½

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miles of subway extension. During the first World War, Mr. Blewitt served at Gallipoli, and in Egypt, France, Belgium and Italy, first with the Royal Naval Division Engineers, then as a second lieutenant in the Royal Engineers, 101st Field Company, 23rd Division. After the war he became permanent way engineer for the Barrow Hematite Steel Company, Ltd., a temporary position for the purpose of reorganizing its transportation system. Mr. Blewitt came to the United States in November, 1920, and in July, 1922, reentered railway service as a draftsman in the track department of the New York Central. On December 1, 1924, he went with the Nickel Plate as an assistant engineer and on February 1, 1927, he was appointed structural designer in the bridge department. Mr. Blewitt was promoted to designing engineer on January 1, 1941, the position he held until his recent promotion, effective September 10.

Alfred D. Wolff, Jr., designing engineer of the New York Central, Lines Buffalo and East, has been appointed to the newly-created position of research engineer, with headquarters as before at New York. Mr. Wolff was born on July 21, 1884, at Tremont, Pa., and graduated in civil



Alfred D. Wolff, Jr.

engineering from the University of Pennsylvania in 1907. Mr. Wolff then taught railroad engineering subjects at the University of Pennsylvania for two years, after which he served for a time as engineer of timber tests for the United States Forestry Service at Purdue University and the University of Colorado. He entered railroad service on June 3, 1910, as a draftsman in the engineering department of the New York Central at New York, becoming assistant engineer on January 1, 1912. From April to December, 1916, he was resident engineer at Poughkeepsie, N.Y., then serving until 1918 as assistant district engineer, Hudson River Connecting road, on the Castleton cut-off. Mr. Wolff served as assistant district engineer at Albany, N.Y., from 1918 to 1922, when he became assistant engineer in charge of valuation Order No. 3 work, Buffalo and East, at New York. In 1926, he was appointed assistant engineer, New York Terminal district, assigned to the West Side improvements, and in April, 1938, he became designing engineer at New York.

Lynn B. Holt, whose retirement as assistant district engineer on the New York Central, with headquarters at Cleveland, Ohio, was reported in the October issue, entered railway service in 1894 as a rodman on the Chicago, Rock Island & Pacific. He was promoted to draftsman in 1895 and a year later to assistant engineer, which position he held until 1901, when he was promoted to division engineer on the lines in Iowa and Missouri. He was subsequently appointed division engineer of the Iowa division, serving in that capacity until 1906, when he went with the Lake Shore & Michigan Southern (now part of the New York Central) as assistant engineer. Mr. Holt was appointed office engineer to the chief engineer of the New York Central, lines west of Buffalo, with headquarters at Cleveland, in 1917, and he continued in this position until 1924, when he was promoted to engineer of track, with the same headquarters. In the latter part of 1940, Mr. Holt was appointed assistant district engineer, with headquarters as before at Cleveland.

E. C. Shreve, whose appointment as division engineer of the Elkins division of the Western Maryland, with headquarters at Cumberland, Md., was announced in the October issue, obtained his higher education at Ohio university. Mr. Shreve started his engineering career with the West Virginia State Roads Commission, and later served with the United States Geodetic Survey. Subsequently, he taught mathematics and engineering at Potomac college, Keyser, W. Va., and West Virginia university, and, while holding these positions, he served frequently as a consultant to various engineers and contractors. He entered the service of the Western Maryland in June, 1940, as an assistant engineer at Hagerstown, which position he held until his recent promotion to division engineer.

Ervin J. Bayer, whose promotion to assistant district engineer on the New York Central (Michigan Central), with headquarters at Detroit, Mich., was reported in the October issue, was born at



Ervin J. Bayer

Cincinnati, Ohio, in April, 1888, and was graduated from Purdue University in 1910. He first entered railway service on July 5, 1910, with the Cleveland, Cincinnati, Chicago & St. Louis (Big Four—part

(Continued on page 850)



BUDA Tie Nipper

ECONOMICAL — Saves at least one man's time in tampering or spiking; no men needed to raise or pry tie for these operations.

SAFE — Can be released and removed from track in 10 seconds or less.

LOW COST — Will pay for itself in less than a week's time on tie replacing work.

REGULAR SECTION CREWS
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BUDA RAIL BENDER

- Bends rail cold—in the field!
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SAVES MAN-HOURS—3 men with Buda-Clark liners can align more rail than 11 men with lining bars!

SAFE—To clear trains, lining bar is removed and liner left in position, little time lost!

Pays for itself in one day's lining! . . . Does not raise track.

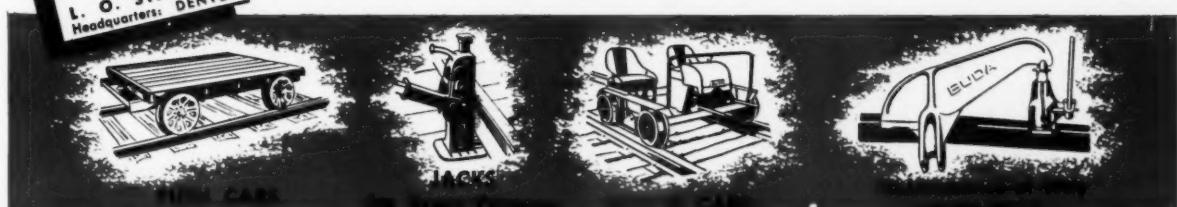
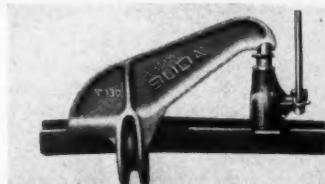


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of the New York Central System), serving as an assistant engineer at various points until 1914. He was then advanced to assistant engineer maintenance of way, and after serving in this capacity at various locations he was appointed acting engineer maintenance of way at Mt. Carmel, Ill., in 1918. After two years in the latter capacity, Mr. Bayer returned to the position of assistant engineer maintenance of way, holding this position at Galion, Ohio, until 1922, when he was made engineer maintenance of way of the Evansville, Indianapolis & Terre Haute (part of the Big Four) with headquarters at Washington, Ind., being transferred to the Peoria & Eastern (part of the N. Y. C. system) with headquarters at Indianapolis, Ind., in 1924. Six years later he became division engineer on the Big Four at Indianapolis, returning to the P. & E. as assistant division engineer in 1933. In 1938, Mr. Bayer was transferred to Springfield, Ohio, on the Big Four, and in 1939, he was appointed division engineer on the N. Y. C. at Jersey Shore, Pa. Mr. Bayer was transferred to the River division at Weehawken, N.J., in 1940, where he remained until his recent promotion.

Track

J. Warne has been appointed roadmaster on the Canadian Pacific at Manyberries, Alta.

Otto E. Ziegler has been appointed assistant roadmaster on the Kansas division of the Union Pacific, with headquarters at Kansas City, Mo.

B. F. Wyrick, track supervisor on the Atchison, Topeka & Santa Fe at Lakin, Kan., has been promoted to assistant roadmaster at Springfield, Colo.

The headquarters of **H. E. Wall**, supervisor of track on the New York Central at Painesville, Ohio, have been transferred to Ashtabula, Ohio.

W. N. Rice, instrumentman on the Illinois Central at Waterloo, Iowa, has been appointed acting supervisor of track at Freeport, Ill., succeeding **C. E. Weller**, who has been granted a leave of absence for military service.

A. Mooney, roadmaster on the Canadian Pacific at Empress, Alta., has been transferred to Leader, Sask., succeeding **D. R. Johnston**, who in turn has been transferred to Empress, relieving Mr. Mooney.

D. L. Cutler, roadmaster on the Chicago, Milwaukee, St. Paul & Pacific at Horicon, Wis., has been transferred to Beloit, Wis., succeeding **M. E. Noel**, who, in turn, has been transferred to Horicon.

A. G. Watkins, track supervisor on the St. Joseph division of the Chicago, Burlington & Quincy, has been promoted to roadmaster at Milan, Mo., succeeding **P. J. Melody**, who has been transferred to Centerville, Mo. Mr. Melody replaces **W. M. Swanson**, who retired on October 12 after 50 years of service.

Virgil Acrea has been appointed supervisor of track on the New York Central (Big Four) at Hillsboro, Ill., succeeding **Alex Haxton**, who has been appointed section foreman at Hillsboro. **W. H. Risley** has been appointed supervisor of track at

Railway Engineering and Maintenance

Washington, Ind., succeeding **Frank King**, who has retired.

P. J. Schmitz, roadmaster on the St. Louis-San Francisco at Kansas City, Mo., has been transferred to Amory, Miss., succeeding **H. L. Woldridge**, whose promotion to division engineer at Ft. Scott, Kan., is reported elsewhere in these columns. **F. N. Beighley** has been appointed roadmaster at Kansas City, replacing Mr. Schmitz.

F. E. Schaumburg, roadmaster on the Chicago & North Western at West Chicago, Ill., has been transferred to DeKalb, Ill., and **M. L. Bradbury**, roadmaster at South Pekin, Ill., has been transferred to West Chicago. **M. J. Fayram**, roadmaster at Belvidere, Ill., has retired and the position of roadmaster at that point has been abolished. **C. C. Brown**, roadmaster at Norfolk, Neb., has been transferred to Sioux City, Iowa, succeeding **R. E. Meyer**, who has been transferred to Sterling, Ill., relieving **A. E. Benson**, who has been assigned to other duties.

John H. Stitt, whose promotion to roadmaster on the Southern Pacific, with headquarters at Susanville, Cal., was reported in the October issue, was born at Ogden, Utah, on August 14, 1909, and entered railway service on March 13, 1931, as an extra gang laborer on the Southern Pacific at Ogden, later serving as a section laborer and a motor car operator for the roadmaster. In 1937 he was promoted to relief foreman and on September 13, 1937, he was advanced to section foreman at Thorne, Nev. Mr. Stitt later served as an extra gang foreman and in 1941 was promoted to general foreman on the Salt Lake division, which position he held until his recent promotion.

F. E. Mayne, assistant supervisor of track on the Illinois Central at Memphis, Tenn., has been promoted to supervisor of track, with the same headquarters, a newly created position and **N. W. Copp**, section foreman at Water Valley, Miss., has been advanced to assistant supervisor of track at Grenada, succeeding Mr. Mayne. **E. R. Word**, supervisor of track at Waterloo, Iowa, has been transferred to the territory formerly under the jurisdiction of **J. R. Wartchow**, supervisor of track at Waterloo, who has been granted a leave of absence for military service. **J. S. Foley**, section foreman at Cherokee, Iowa, has been promoted to supervisor of track at Waterloo, relieving Mr. Word.

Clark Sansom has been appointed track supervisor on the Nashville, Chattanooga & St. Louis at Cowan, Tenn. **N. O. Stone** has been appointed track supervisor at Decherd, Tenn. Mr. Sansom was born on August 1, 1892, and entered railway service as a track laborer on the N. C. & St. L. on April 1, 1910. He was promoted to assistant foreman on February 1, 1916, and on August 1, 1916, he was advanced to section foreman. Mr. Sansom was appointed extra gang foreman in February, 1925, and served as extra gang and section foreman until his recent promotion to track supervisor.

Mr. Stone was born on February 24, 1882, and entered railway service as a track laborer on the N. C. & St. L. in January, 1902. He was promoted to sec-

tion foreman in May, 1905, and in August, 1916, he was advanced to track supervisor, which position was abolished in 1931. He was reappointed track supervisor on August 24, 1942.

John S. Mills, acting supervisor of track on the Illinois Central, has been promoted to supervisor of track at Fulton, Ky., succeeding **W. H. Purcell**, who has been assigned to other duties because of ill health. Mr. Mills was born at Oxford, Miss., on May 11, 1891, and entered railway service on June 1, 1913, as a team gang foreman on the Illinois Central at Sardis, Miss. On October 2, 1916, he became a track laborer at Grenada, Miss., and on March 1, 1917, he was promoted to assistant foreman. Mr. Mills was advanced to section foreman at Coffeeville, Miss., on October 1, 1917, and was later transferred successively to Elliott, Miss., and Fulton, Ky. On March 28, 1941, he was sent by the Illinois Central to build a railroad at an ordnance plant in Tennessee and later sent to Illinois on track construction for an ordnance plant in that state. Mr. Mills was recalled to the Illinois Central on May 1, 1942, as acting supervisor of track, which position he held until his recent promotion, effective October 1.

Thomas J. Vansandt, whose promotion to roadmaster on the Southern Pacific, with headquarters at Glendale, Ore., was reported in the October issue, was born at Seligman, Mo., on November 17, 1900, and entered railway service in October, 1919, as a laborer on the Oregon Short Line (now part of the Union Pacific). He resigned in May, 1922, but returned to railway service in April, 1925, as a section laborer at Niland, Cal. Three months later, he was promoted to section foreman at Ogilby, Cal., later being transferred successively to Calexico, Cal., Indio, and various points on the Coast division. In June, 1941, he was advanced to general foreman on the Coast division and also served from time to time as a relief roadmaster at various points. In February, 1942, he was assigned to the Bureau of Reclamation as general foreman in charge of completing 30 miles of new line from Delta Junction, Cal., to Redding and then remained as general foreman on the Shasta division until his recent promotion.

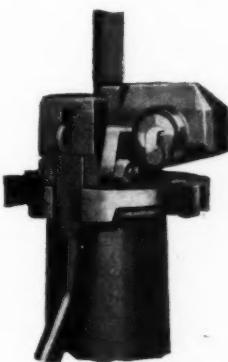
Carl O. Hogland, whose promotion to roadmaster on the Southern Pacific at Carrizozo, N.M., was reported in the September issue, was born at Ft. Bliss, Tex., on August 5, 1914, and studied a correspondence course. He entered railway service on September 1, 1931, as a section laborer on the Southern Pacific and in 1933 he was promoted to machine operator. In 1936 Mr. Hogland was advanced to relief extra gang and section foreman and on October 23, 1941, he was promoted to general foreman, serving in that capacity and as acting roadmaster on various districts of the Rio Grande division until his recent promotion.

Nathaniel K. Farr, whose promotion to supervisor of track on the Illinois Central, with headquarters at Baton Rouge, La., was reported in the September issue, was born at Hamburg, Miss., on January 15, 1889, and entered railway service on January 1, 1906 as a track apprentice on

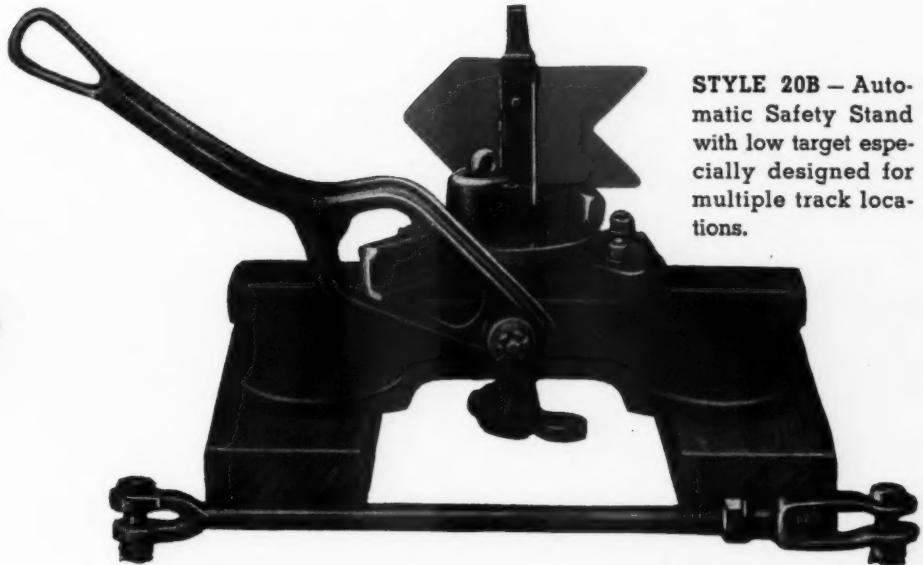
(Continued on page 852)



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STYLE 20B—Automatic Safety Stand with low target especially designed for multiple track locations.

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At hand-thrown switch locations, the inherent automatic safety feature of these switch stands prevents damage to the stands and switch points, even though trailed through when set in the closed position. By reducing the possibility of such break-downs, unnecessary delays and time-consuming repairs to track and equipment are minimized.

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RAMAPO AJAX DIVISION



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the Illinois Central. On August 1, 1900, he was advanced to assistant extra gang foreman and served in that capacity during the working seasons until December, 1911, when he was promoted to section foreman on the Vicksburg division. Mr. Farr was located at Centreville, Miss., at the time of his recent promotion, effective August 15. From 1922 to 1930 he served as vice-general chairman of the Brotherhood of Maintenance of Way Employees on the Illinois Central and as local chairman from 1922 until his recent promotion.

Audif Jackson Winters, whose promotion to roadmaster on the Chicago, Rock Island & Pacific, with headquarters at Ft. Worth, Tex., was reported in the August issue, was born at Mt. Pleasant, Tex., on November 25, 1900, and entered railway service in July, 1915, as a section laborer on the Rock Island at Mansfield, Ark., working about two months. He returned to the Rock Island on June 11, 1920, as a section laborer at Barber, Ark., and was promoted to relief section foreman the following year. In 1923 he was advanced to section foreman and worked as section foreman, extra gang foreman and section laborer until September, 1938, when he was promoted to track supervisor on the Oklahoma division, later being transferred successively to the Arkansas and Southern divisions. In April, 1942, he was appointed steel gang foreman, which position he held until his promotion.

Hiram Lee Standridge, whose promotion to roadmaster on the Chicago, Rock Island & Pacific, with headquarters at Fairbury, Neb., was reported in the September issue, was born at Alvarado, Tex., on October 7, 1907, and studied a correspondence course on track work. He entered railway service during the summer of 1923 as a section laborer on the Ft. Worth & Denver City and continued to work summers until 1929, after which he worked steady as freight house trucker, bridge and building laborer, section laborer, relief section foreman, extra gang foreman and machine operator. On October 18, 1937, he went with the Rock Island as an assistant extra gang foreman and on November 8, 1937, he was promoted to track supervisor at Bridgeport, Tex. On April 1, 1939, he was transferred to Booneville, Ark., and two months later, he was transferred to Amarillo, Tex. Mr. Standridge was transferred to Little Rock, Ark., on March 1, 1940, and to Allerton, Iowa, on January 1, 1940, where he was located until his recent promotion.

F. L. Cagwin, roadmaster on the New York, Ontario & Western, whose promotion to district engineer, with headquarters at Mayfield Yard, Pa., was noted in the September issue, was born on April 22, 1884, at Verona, N.Y. Mr. Cagwin obtained his higher education at Syracuse University, graduating in civil engineering in 1907. For a year following his graduation, he served with the Alpha Portland Cement Company. In August, 1909, he entered the service of the N. Y. O. & W. at Scranton, Pa., being sent to Norwich, N.Y., as a transitman in 1912. In November, 1916, Mr. Cagwin was further promoted to roadmaster of the Scranton division, with headquarters at Mayfield Yard. He was holding this

Railway Engineering and Maintenance

position at the time of his recent promotion to district engineer, which became effective on August 1.

F. B. Cox, assistant supervisor of track on the New York Central, with headquarters at New York, has been promoted to supervisor of track of Subdivision 28 of the Electric division, with the same headquarters, to succeed **John P. Ensign**, whose appointment as engineer maintenance of way of the Pittsburgh & Lake Erie is noted elsewhere in these columns. **R. J. Klueh**, a transitman in the engineering corps of the New York Central at New York, has been promoted to assistant supervisor of track of Subdivision 28 of the Electric division, succeeding Mr. Cox.

E. V. Grogan, assistant supervisor of track of Subdivision 14 of the Buffalo division, with headquarters at Lackawanna, N.Y., has been promoted to supervisor of track of Subdivision 26 of the Pennsylvania division, with headquarters at Jersey Shore, Pa., succeeding **W. J. Kerman**, who has been transferred to Subdivision 11 of the Syracuse division, with headquarters at Rochester, N.Y. Mr. Kerman replaces **W. G. Cowie**, whose promotion to division engineer of the River division at Weehawken, N.J., is noted elsewhere in these columns. **Frank Burns** has been appointed assistant supervisor of track of Subdivision 29 of the Eastern division, with headquarters at Brewster, N.Y., to succeed **H. J. Kingsland**, who has been transferred to Subdivision 14 of the Buffalo division at Lackawanna, to replace Mr. Grogan.

Mr. Cox was born on July 22, 1889, at Cornwall, N.Y. After a public school education, he entered railway service with the New York Central as a track laborer on April 5, 1902. On February 8, 1911, Mr. Cox was advanced to assistant section foreman, serving alternately in this position and as section foreman until November 16, 1933, when he was promoted to assistant supervisor of track, with headquarters at Weehawken. He was transferred to New York on March 1, 1941, where he remained until his recent promotion to supervisor of track.

Mr. Grogan was born on February 11, 1899, at Philmont, N.Y. Following a public school education, Mr. Grogan entered the service of the New York Central on February 13, 1913, as a track laborer at Philmont. On May 16, 1916, he was promoted to assistant section foreman, and for a time thereafter he served alternately in this capacity and as section foreman. On August 1, 1933, Mr. Grogan was promoted to assistant supervisor of track at Canandaigua, N.Y., being transferred to Lackawanna, N.Y., on October 11, 1937. He remained at the latter point until his recent promotion to supervisor of track.

Bridge and Building

G. W. Carbaugh has been appointed acting supervisor of bridges and buildings on the Norfolk division of the Norfolk & Western, with headquarters at Crewe, Va., to succeed **A. C. Tinsley**, who has entered military service.

W. H. Brown, whose promotion to master carpenter of the Eastern division of the Alton, with headquarters at Blooming-

ton, Ill., was reported in the October issue, was born at Odell, Ill., on February 28, 1879, and entered railway service on December 5, 1916, as a bridge and building carpenter on the Chicago & Alton (now the Alton) at Dwight, Ill. On July 26, 1920, he was promoted to bridge and building carpenter foreman at Bloomington, and on March 1, 1929, he was advanced to assistant supervisor of bridges and buildings. On February 15, 1931, he was appointed bridge and building foreman, which position he held until his recent promotion, effective September 15.

Obituary

E. C. Morrison, for many years division engineer of the Coast division of the Southern Pacific, who was in charge of the relocation work at San Jose, Cal., in 1935 and 1936, died at San Francisco, Cal., on October 1 at the age of 72.

Charles K. Lawrence, who retired as chief engineer of the Central of Georgia on June 1, 1926, died at his home in Savannah, Ga., on September 12, after a short illness, at the age of 86. Mr. Lawrence entered the service of the Central of Georgia in 1899 as engineer of construction and served as chief engineer in charge of the engineering department for 20 years.

Henry M. Gully, assistant principal assistant engineer of the Gulf, Mobile & Ohio, with headquarters at Meridian, Miss., died in a motor car accident north of Meridian on September 21. Mr. Gully was born at Macon, Miss., on December 5, 1901, and graduated from Mississippi State College in June, 1924. In May, 1925, he entered railway service as an instrumentman on the Gulf, Mobile & Northern (now the G. M. & O.) and in 1927, he was promoted to resident engineer at Union, Miss. Mr. Gully was advanced to roadmaster, with the same headquarters, and with jurisdiction over the entire system in 1937 and the following year, he left railroad service for other employment. He returned to the G. M. & O. in May, 1942, as assistant principal assistant engineer, with headquarters at Meridian.

W. R. Dawson, retired assistant to the general manager of the Norfolk & Western, and formerly general supervisor of maintenance of way and structures on this road, died at his home at Roanoke, Va., on September 16. Mr. Dawson was born on April 21, 1870, in Tazewell county, Va., and entered the service of the N. & W. at the age of 19 as a bridge carpenter on the Pocahontas division. In January, 1893, he was promoted to bridge foreman, becoming master carpenter in August, 1896. Four years later, Mr. Dawson left this road to handle a special construction contract for the Virginia & Southwestern (now part of the Southern). In February, 1902, he returned to the N. & W., and in 1905 he was made general supervisor of maintenance of way and structures. Mr. Dawson became assistant superintendent of the Pocahontas division in April, 1907, and in February, 1915, he was promoted to assistant to the general manager, holding this position until his retirement in January, 1936.

(Continued on page 854)

Greater Durability...Speed... with POZZOLITH (CEMENT DISPERSION)



One of several bridges of The Atchison, Topeka & Santa Fe Railroad in which Pozzolith Concrete was used.

ALWAYS on the alert for important industrial developments, leading railroads were quick to recognize the outstanding advantages of Cement Dispersion—a discovery which has produced concrete of unusual durability and strength . . . insured earlier use of projects . . . reduced the cost of concrete construction.

Reflecting today's technologic trend, Cement Dispersion is an application of the **dispersion principle**, responsible for modern developments in rubber, steel, plastics, ceramics and many other basic materials. Its results of greatly increased concrete efficiency are produced by the specific dispersing agent for cement (lignin derivative marketed as Pozzolith).

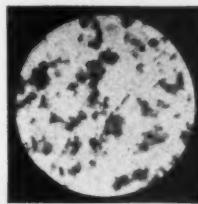
During ten years of service, Cement Dispersion (Pozzolith), has been employed in millions of yards of concrete for every type of project. Today it is being used by railroads to meet the important construction demands of durability, speed and economy.

Write for illustrated Pozzolith booklet and Research Paper No. 36—"Economics of Cement Dispersion".

THE MASTER BUILDERS COMPANY
CLEVELAND, OHIO TORONTO, ONTARIO

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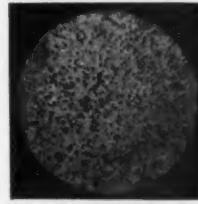
WITHOUT POZZOLITH



Cement suspended in water
UNDISPERSED

In a normal concrete mix, cement particles tend to bunch together, thereby (1) limiting hydration and (2) trapping water within the cement clumps. (See photomicrograph at left).

WITH POZZOLITH



Cement suspended in water
DISPERSED

Cement Dispersion drives these particles apart and (1) exposes their entire surface area to hydration, at the same time (2) making the water entrapped in the clumps available for lubrication of the mix. (See photomicrograph at left).

OTHER MASTER BUILDERS PRODUCTS USED EXTENSIVELY BY RAILROADS

EMBECO—non-shrink grouting and concrete repair material.

MASTERPLATE—non-colored and colored armoured surface floors.

OMICRON MORTARPROOFING—shrinkage control for masonry mortars.

MASTERKURE—membrane curing agent for all concrete.

MASTER BUILDERS



Association News

Roadmasters' Association

President Banion has called a meeting of the Executive committee at Chicago on Saturday, December 5.

Railway Tie Association

Members of the Executive committee met at Chattanooga, Tenn., on October 20 to consider the problems confronting the producers of crossties under recent government regulations and to plan for the next annual meeting of the association.

Wood-Preservers' Association

Members of the Executive committee met in Chicago on October 22 to transact routine business and to develop tentative plans for the thirty-ninth annual meeting to be held at the Netherland Plaza Hotel, Cincinnati, Ohio, on April 27-29, 1943.

Bridge and Building Association

At a meeting of the newly elected Executive committee immediately following the conclusion of the annual meeting on October 22, it was voted to hold the next annual meeting on October 19-21, 1943. Chicago was selected as the location for this meeting by vote of the association earlier in the day. Arrangements were also made to transfer the records to the office of the newly elected secretary, Lorene Kindred, Room 822, 310 South Michigan avenue, Chicago.

Maintenance of Way Club of Chicago

One hundred and thirty-seven members and guests were present at the first fall meeting of the club, which was held in the Ambassador room of Huyler's restaurant in the Straus Building, Chicago, on the evening of October 26. Following dinner, H. R. Clarke, chief engineer maintenance of way, Chicago, Burlington & Quincy system, discussed The Maintenance Man's Responsibilities in Time of War, and urged that each maintenance man live up to these responsibilities as his important contribution to the war effort.

The next meeting of the club, to be held on November 23, at its regular meeting place, will be addressed by G. P. Palmer, engineer maintenance and construction, Baltimore & Ohio Chicago Terminal, on Keeping Our Terminals Open For War-Time Traffic This Winter.

American Railway Engineering Association

Four standing committees of the association have scheduled meetings during November: Cooperative Relations With Universities, at Cleveland, Ohio, on November 9; Track, at Chicago, on November 12; Masonry, at Chicago, on November 12 and 13; and Economics of Railway Labor, at Chicago, on November 13.

Late in October, Bulletin No. 433 was mailed to members, this bulletin, among other things, including a detailed report

of the Committee on Impact, and a monograph by Roscoe Owen, on Pile Tests. The November Bulletin of the association, No. 434, which will be mailed to members late in the month, will include the reports of five standing committees to be presented at the annual meeting next March, as follows: Electricity; Signals and Interlocking; Water Service, Fire Protection and Sanitation; Economics of Railway Location and Operation; and Waterways and Harbors.

Eight committees held meetings during October, four concurrent with the annual meeting of the American Railway Bridge and Building Association. The committees which met included the following: Iron and Steel Structures, at Pittsburgh, Pa., on October 8 and 9; Impact, at Chicago, on October 12; Yards and Terminals, at Cleveland, Ohio, on October 14; Waterproofing of Railroad Structures, at New York, on October 15 and 16; Water Service, Fire Protection and Sanitation, at Chicago, on October 20; Wood Preservatives, at Chicago, on October 20; Wood Bridges and Trestles, at Chicago, on October 21; and Buildings, at Chicago, on October 21 and 22.

Jersey enabled the works to obtain anthracite coal and to bring in iron ore from distant mines. The railroad gave business to the Taylor works for rails, coupling links and pins as well as car wheels, axles and other railroad equipment.

In 1892 the Taylors obtained the American rights for the manufacture of manganese steel, which had been invented by Robert Hadfield of England. In association with William Wharton, Jr., & Co., of Philadelphia, the Taylor Iron & Steel Co., as the High Bridge works was then known, installed the first railroad frog with a cast manganese steel plate in its center on August 28, 1894, in Brooklyn, N.Y., and some months later the first curved manganese steel rail was installed in Philadelphia.

In 1912, the Taylor Iron & Steel Co. absorbed William Wharton, Jr., & Co., and became the Taylor-Wharton Iron & Steel Co. In 1915 a new plant at Easton, Pa., was built which, during World War I, produced 538,136 shell forgings. Taylor-Wharton also made forgings for four-inch naval guns, tank treads, helmets, railroad and marine equipment and much other material for war purposes.

Personal

George W. Hoover has been appointed eastern sales representative of the **Kalamazoo Railway Supply Company**, Kalamazoo, Mich., with headquarters at New York. Mr. Hoover will handle both domestic and export sales. **Joseph F. Leonard** has been appointed southeastern sales representative, with headquarters at Richmond, Va.

Henry A. Roemer, Jr., formerly manager of sales of steel and wire products for the **Pittsburgh Steel Company**, has been appointed assistant general manager of sales. **Norman F. Melville**, formerly assistant manager of sales of steel and wire products, has been appointed manager of sales of that department to succeed Mr. Roemer.

Trade Publications

Link-Belt Speeder LS-60.—An eight-page illustrated book, No. 1929, has been published by the Link-Belt Speeder Corporation, Chicago, describing the LS-60 heavy-duty $\frac{1}{2}$ -yd. crawler shovel, which can be converted also into a dragline or crane. The book includes illustrations showing the LS-60 at work and the construction features of this machine. Also included are tables of working ranges, lifting capacities, etc.

Railroad Accessories.—Oliver Iron and Steel Corporation, Pittsburgh, Pa., has published Catalogue No. 4 which illustrates many of the items this company manufactures for the railroads. The catalogue, which consists of 50 pages, contains sections on commercial bolts, nuts, rivets and construction specialties; track accessories; and car builders specialties. Also included are suggestions for ordering and weight and conversion tables. The catalogue is well illustrated with photographs of each item, is attractively printed in color, and is wire-bound with an embossed imitation leather cover.

Supply Trade News

General

All divisions of the **American Rolling Mill Company**, Middletown, Ohio, have received the Army-Navy "E" award for excellence in production. The Army-Navy "E" burgee and lapel buttons were presented to the Middletown and Hamilton, Ohio, divisions and their employees on October 5 and similar presentation ceremonies were held on succeeding days at the Butler, Pa., Ashland, Ky., and Zanesville, Ohio, plants. Charles R. Hook, president of the company, accepted the banner and buttons on behalf of the divisions and the employees.

The **Taylor-Wharton Iron & Steel Co.**, celebrated its 200th year in the iron industry and the 50th year of making Hadfield's manganese steel on October 17, 1942, when representatives of the Army and Navy, and George R. Hanks, president of the company, spoke, and the faculty and pupils of the local High Bridge, N.J., high school staged a pageant based on the company's history.

The company, originally named the Union Iron Works, was founded by William Allen and Joseph Turner, members of the Philadelphia Common Council and of the Pennsylvania Provincial Assembly, and the lease whereby Mr. Allen obtained 3,000 acres adjacent to a forge already in existence, and ruins of which still stand on the Taylor-Wharton grounds, was dated December 1, 1742. Robert Taylor arrived in America from Ireland in 1758 at the age of 18 and first joined the Union Iron Works as a bookkeeper, becoming the works manager at Union Furnace in 1769. He took active charge of the iron works in 1780 and continued in control of the works after the deaths of both Allen and Turner, in 1780 and 1783, respectively.

The building of the Central of New



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Newly revised and reprinted — a comprehensive book on the properties, uses and best methods of handling, treatment, etc. of tool, stainless and other alloy steels. Plenty of tables to facilitate quick reference and selection. 124 pages, pocket-sized.



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An informative booklet that gives clear and detailed data on the various types of Tool Steels, their properties and handling. Excellent for training courses in metals and metal working.

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The Allegheny Ludlum "Handbook of Special Steels" is a bible of

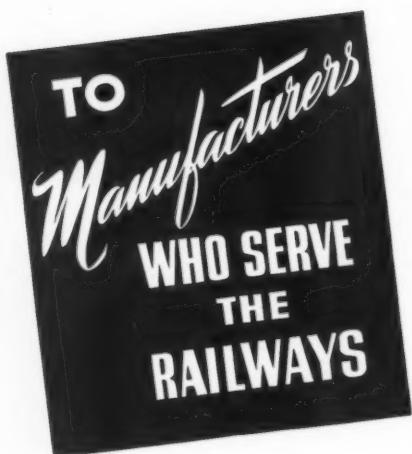
data for production men, and our "Elementary Discussion on Tool Steels" is invaluable for use in apprentice and training courses.

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STEEL CORPORATION**
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"New Faces"

"Boss, this job's getting tougher every day," ejaculated the star railway salesman to his sales manager.

"What's the matter now, Bill?" countered the sales manager.

"So many new men to see and tell about our products."

"More than usual?"

"Twice as many. I never saw so many changes."

"What's bringing that about?"

"Several things. Men leaving for military service, old men cracking up under the pressure, subdividing territories—I run into new men in nearly every office I go into."

"That does add a lot to your work."

"It trebles it, at least. And the worst of it is that I just can't keep up with the changes."

"How can we help you, Bill?"

"The best thing that you can do is to give me more advertising in *Railway Engineering and Maintenance*."

"For what?"

"To tell our story to these new men."

"That you call on?"

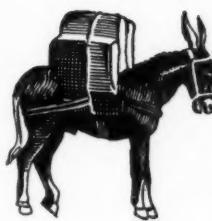
"In part, yes. It'll save me a lot of time when I get around to see them—and it'll keep us before them between my calls."

"Yes—"

"And, boss, it'll help even more with the men I can't get to. They're just as important as the men on the main line. You know that magazine reaches all of them. It's *their* paper, and they read it from cover to cover. You never see it in the wrappers."

"You're right, Bill. You *do* need this help in contacting the new men. I'll see that you get it—and it'll help to keep us before our old friends, too."

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READ BY MAINTENANCE OFFICERS OF ALL RANKS

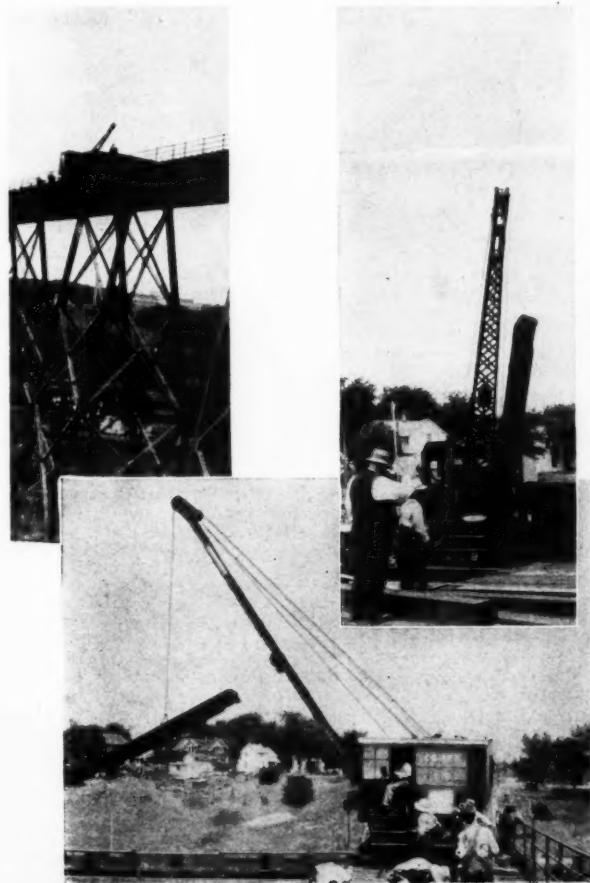


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Every Burro Feature
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Check over the feature you need in a crane for bridge building and construction work and you'll find them all in a BURRO: Traveling speed, lifting power, draw bar pull, 6,000 lb. . . . a boom that can reach out and at the same time is mounted on elevated boom heels to give extra clearance in close quarters. All of this in a compact heavy little unit with so short a tail swing that it can turn clear around without fouling the adjacent track and handles perfectly in the closest quarters.

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Railway Engineering and Maintenance

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Coming in . . . *Lights Up!*

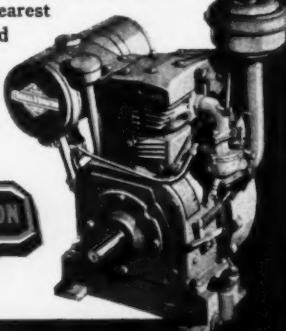
Roaring planes returning to outlying and secret air bases far from electric power lines — inky blackness below. Then compact, portable units, powered with flash-starting Briggs & Stratton gasoline motors, swing into action and floodlights gleam. Ample light for a safe landing and for speedy service. This is but one of scores of jobs that more than a million and a half Briggs & Stratton motors are doing daily — with our armed forces everywhere, as well as on farms, in homes and for industry.



For the duration, in ever increasing quantities, Briggs & Stratton 4-cycle, air-cooled motors are being produced only for war and approved civilian uses.

To assist in the conservation of critical materials, owners and operators are urged to give their Briggs & Stratton motors more frequent inspection and care than normal, to avoid unnecessary need for repair parts. If additional service or parts are needed, go to your nearest dealer or an Authorized Service Station.

BRIGGS & STRATTON CORPORATION
Milwaukee, Wis., U. S. A.



November, 1942

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Safe



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He pulls nails out of Plywood so you'll know more about driving them in!

• The nails you use with Douglas Fir Plywood in the future may be unlike the nails you have regularly called for up to now. *First* because war-time restrictions to save metal may have a lasting influence on nail sizes and weights. *Second* because the nail-holding tests now being conducted as part of the Douglas Fir Plywood Association's intensified research program may prove that under various conditions shorter or lighter nails—or nails or fasteners of different designs—are more efficient than those previously specified.

Of course the *complete* answer to this new nailing problem—and to scores of others—has not yet been determined. But by the time Douglas Fir Plywood is again generally available, our research men will be able to tell you how to use it to far better advantage than ever before. Douglas Fir Plywood Association, Tacoma, Washington.

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Plywood Industry
is devoting its en-
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We know this pro-
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REMEMBER—there's a grade or type of Douglas Fir Plywood for every purpose. A genuine panel bears one of these "grade trade-marks":

EXT-DFPA—waterproof type
PLYWALL—wallboard grade
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Real Lumber
**MADE LARGER, LIGHTER
SPLIT - PROOF
STRONGER**

"A PRODUCT OF AMERICA'S ETERNALLY REPLENISHING FORESTS"

Authorities were placed on full alert in the area last night, following a report that a submarine had surfaced close to shore.

Maritime Record Being Set Today

(By Associated Press)

American shipyards today were to launch or lay the keels of ships numbering almost half the total of United Nations' vessels announced lost in the western Atlantic since Pearl Harbor.

Labor day was to see 174 new ships go down the ways and the keels of 49 others laid, setting a world's record for maritime construction. Two 173-foot steel submarine chasers were to be launched.



I. B. Cranes Help America's Shipbuilders Keep Up Their Record-smashing Pace

Industrial Brownhoist Cranes are, today, playing a prominent role in America's shipyards from coast to coast. Their extra ruggedness, efficiency and operating speed is a vital factor in making the amazing production records possible. The patented Monitor-type cab on gas and diesel cranes through 40 tons capacity speeds up operator production by providing 360° visibility, better ventilation and less noise. Operating levers are conveniently placed for greater ease of control. Undercarriage, rotating gears, crab mechanism, power plant, boom and rigging are all designed and built to do a faster, uninterrupted job of material handling.

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WHETHER you're constructing an underpass, erecting a bridge, or doing the foundation work for a new building, you want—you must have—speed with safety to meet today's rush schedules. Monotubes offer you that speed with safety wherever they are used for the installation of cast-in-place concrete piling.

Sturdy and rigid, yet light in weight and easy to handle, they give you all of these extra important advantages:

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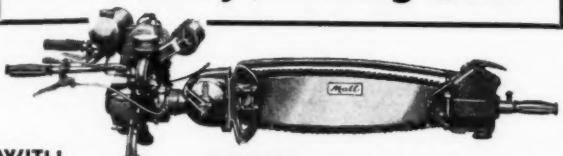
Monotubes are available in a gauge, taper, and size to meet load requirements in every soil condition, and Union Metal's engineers are always at your service. Write today for your copy of the Monotube catalog.

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**CONSERVE Man Hours
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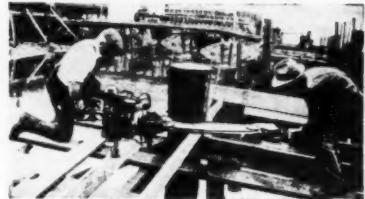


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GASOLINE
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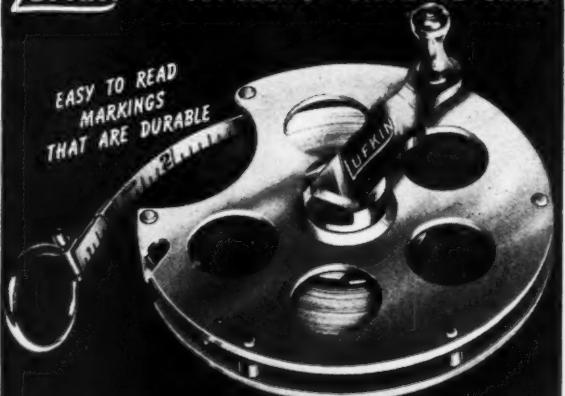
CHAIN SAW



Heavy timbers and piling used in tunnels, trestles, bridges, docks, crossings and other construction can now be accurately squared to size at almost unbelievable speed with a MALL CHAIN SAW. These powerful, high speed saws will operate anywhere on the right-of-way. They use very little fuel and can be sharpened right on the job. The swivel feature prevents stalling and speeds up cutting. Easily transported on a hand car. Also electric and pneumatic models with 24", 36", and 48" cutting capacities. Full details mailed upon request.

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ETC., REQUIRED BY THE ACTS OF CONGRESS OF
AUGUST 24, 1912, AND MARCH 3, 1933**

Of Railway Engineering & Maintenance published monthly at Chicago, Ill., for Oct. 1, 1942.

State of Illinois
County of Cook } Ill.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Elmer T. Howson, who, having been duly sworn according to law, deposes and says that he is the editor of the Railway Engineering and Maintenance and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the above-named publication for the date shown in the above statement required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 337, Postal Laws and Regulations, printed on the reverse of this form, to wit:

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ELMER T. HOWSON, Editor.

Sworn to and subscribed before me this 16th day of October, 1942.
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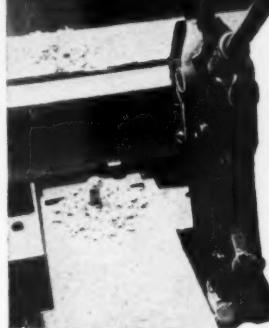
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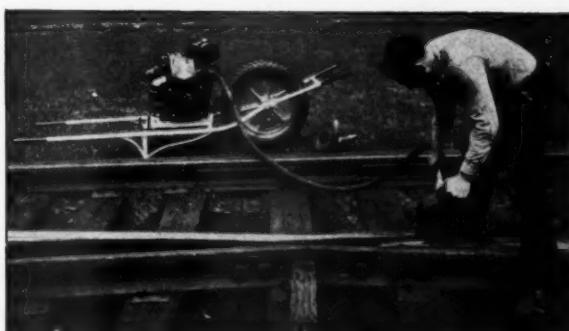
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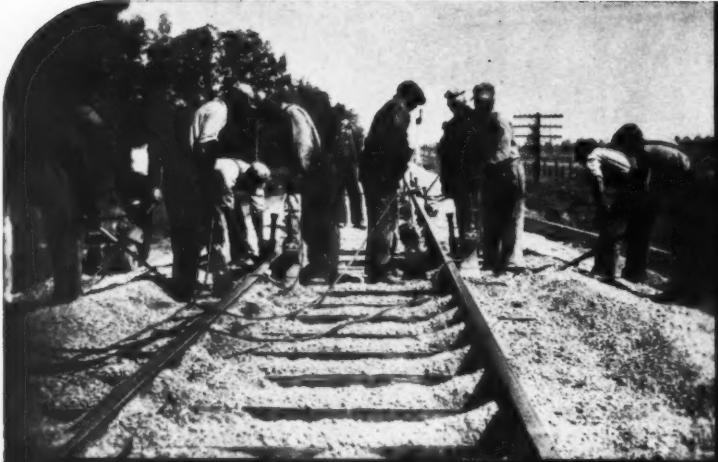
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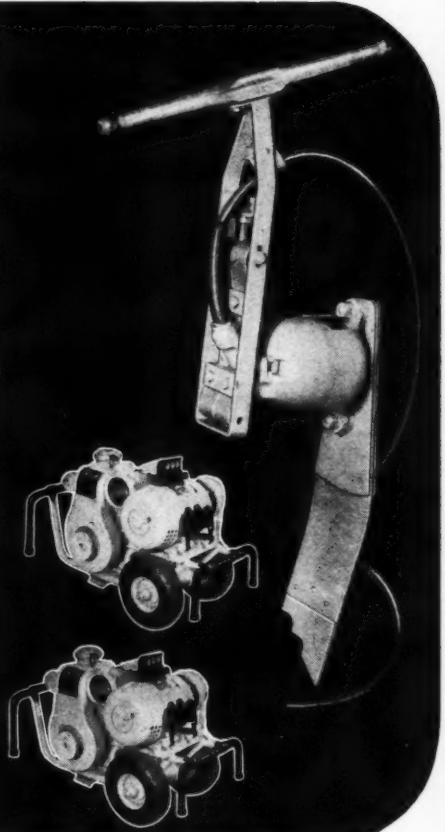
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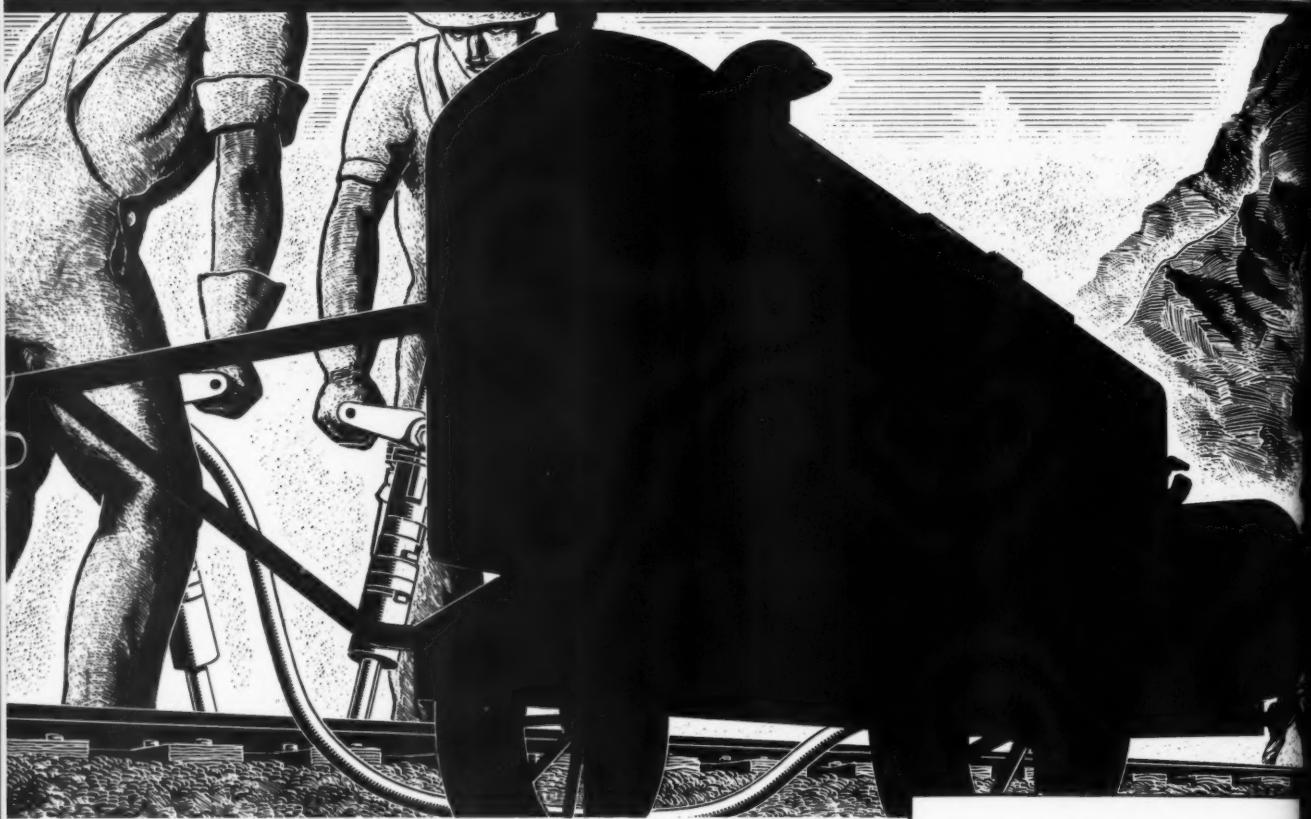
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